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COMPARISON OF THE ROTARY CALCINATION OF TRONA UTILIZING COAL AND NATURAL GAS FIRING

for

SOLVAY MINERALS
GREEN RIVER, WYOMING

PROJECT #: 1-56563-865-00-30
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EXECUTIVE SUMMARY

A test program was performed for Solvay Minerals to determine the feasibility of converting their existing trona rotary calciners from natural gas-fired to coal-fired. The feasibility was evaluated in terms of the (1) effects of coal firing on product quality and process emissions, (2) the flame profile in a combustion chamber, and (3) the potential for ash formation in the combustion chamber during a four day test program performed utilizing a 18" x 12' parallel rotary calciner system.

Laboratory tests were performed to evaluate (1) coal ash fusion temperature, (2) the effect of coal ash on product soluble silica levels, and (3) potential reactions between a mix of coal ash/trona and magnesium refractory brick. Results indicated (1) a minimum ash fusion temperature of 2100°F, (2) increased soluble silica levels when coal ash is present in the product, and (3) no reaction between coal ash/trona and the magnesium brick at temperatures ≤2300°F.

The coal provided for the study was ground to 80% passing 200 mesh and 90% passing 200 mesh using a heated, air-swept vertical roller mill. Based on incomplete combustion observed during an initial shakedown test with the coarser grind, the finer grind was utilized for all coal combustion test phases. Operational instabilities and product particle size variations were observed during coal mill operation. Further testing is recommended prior to final commercial coal mill selection.

Stable rotary calciner operation and product bicarb levels were demonstrated firing natural gas and coal. Full flame retention in the combustion chamber and excellent temperature stability were demonstrated for both fuels. The coal injection rate was varied between 25% and 100%, with 100% representing a firing rate of 1.4 MMBtu/st trona. Calciner product and filter fines samples were collected during stable operating conditions for each of the ten test phases. These samples were shipped to Solvay for product quality determinations. Therefore, a comparison of natural gas and coal firing relative to product quality cannot be made by FFE Minerals.

A comparison of the emission of THC's, CO, NO_x, and heavy metals for natural gas and coal firing as measured at the filter exit indicates the following:

- THC emissions are comparable for both fuels (0.08-0.13 lb/st trona)
- CO emissions are generally higher when firing coal (0.20-0.39 lb/st trona vs 0.12-0.21 lb/st trona for natural gas)
- NO_x emissions increased by nearly 700% when firing 100% coal (1.49 lb NO_2/st trona vs 0.19 lb NO_2/st trona for natural gas firing)
- Only the emission rate of arsenic increased during coal firing

While the higher rate of NO_x emissions associated with coal firing may be reduced using low NO_x burner technology, the NO_x rate will remain greater than that currently emitted with 100% natural gas firing.

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DATE: 13 June 2001	
NUMBER OF PAGES: cover + 5	

AIR

Subject: **Attached**

Jim,

I am sending the attached pages per the request of Brian Field. Please see that our visitors from Brazil receive a copy. Thank you.

Best Regards,

Carol

Cc: M. Rodriguez

Dolly This is a "confidential" project that is in Brazil. I thought you might find the #'s for emissions interesting. They will be here to tour today

Jim M

J:\USERS\CSCHNEID\WPS1\FAXFORM

MRN's bauxite drying system's drying gas handling options are driven by several operational and environmental targets. These targets are not always complementary and FFE Minerals has developed a decision matrix to help MRN choose its preferred solution.

We understand the environmental targets are of prime importance to MRN and as such our analysis does not include options which would violate the any environmental targets.

The Targets considered in this study are as follows:

Environmental Targets
- Particulate 100 mg/nm3
- SO2 5000g / 106 Kcal
- Thickener Effluent Quality Maintained

Operational Targets
- Low Fuel Consumption
- Low Power Consumption
- Low Installed Cost
- Low Maintenance Cost.

The following operating costs and assumptions have been assumed for the model.

Fuel costs	170 USD/ Ton Fuel
Power cost	75 USD/ Mwatt
Caustic Cost	250 USD / ton 73% Concentration.
Design Fuel S	5% S

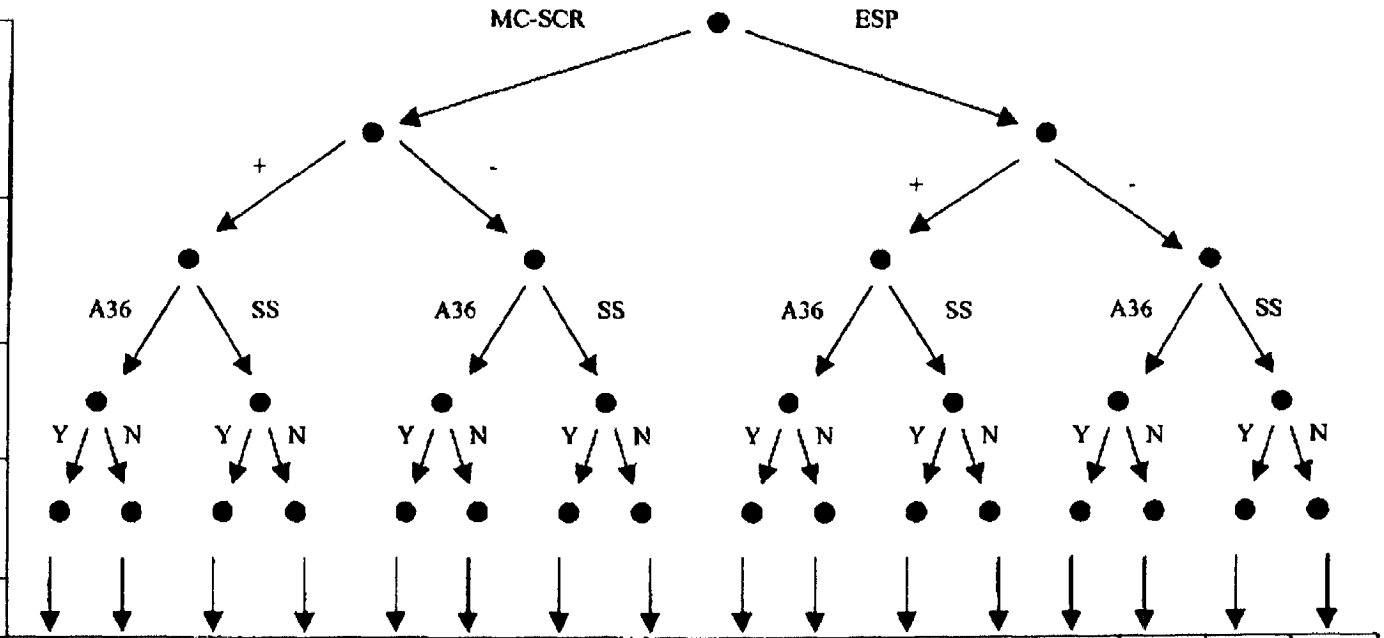
The attached decision tree illustrates all the combinations reviewed by FFEM. Note that at all times FFE Minerals holds the environmental Targets. Cases 1, 3, 5, 7 are not considered because they couple stack SO2 scrubbing with venturi scrubber which is not necessary. The scrubbing will be done in the venturi scrubber proper. Likewise Cases 10, 12, 14, & 16 are removed because they do not allow for SO2 scrubbing after the ESP (the ESP will not scrub SO2).

The remaining cases are left for preliminary fiscal analysis. The costs shown the attached table are considered budgetary (+/- 10%). When MRN selects the preferred option, detailed proposal will be prepared to finalize the scope and price based on Brazilian supply.

Additional operating costs associated with thickener products have not been included in this study. It is FFEM's understanding that a new transformer will be required above 1000 Kw – this has been included here. Also the cost of downtime for maintenance has not been included here.

Maintenance costs are assumed as incremental with multiclone internals replaced 2 times per year and the ESP internals replaced 1 time every 2 years.

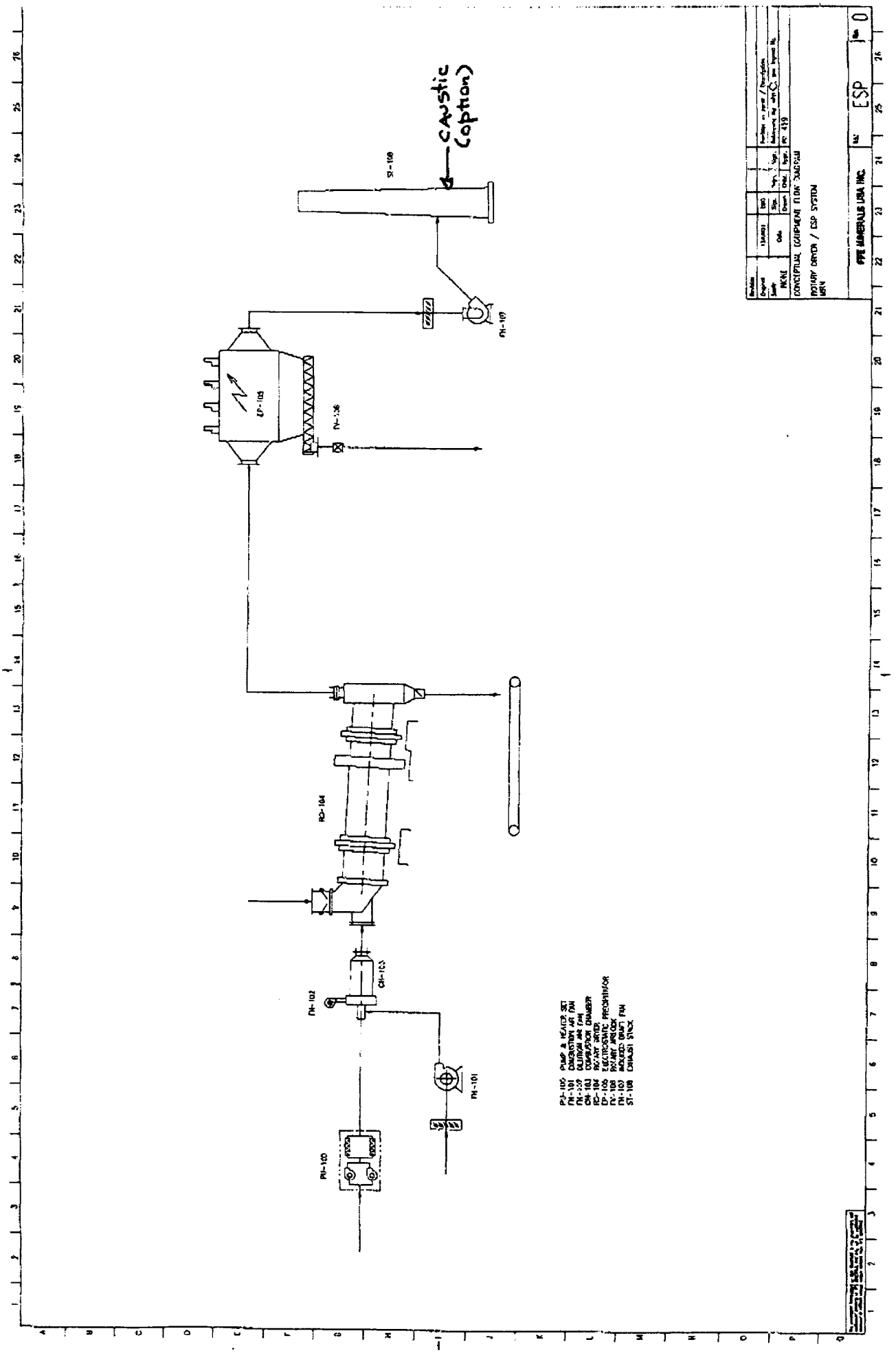
MRN Gas Handling Analysis

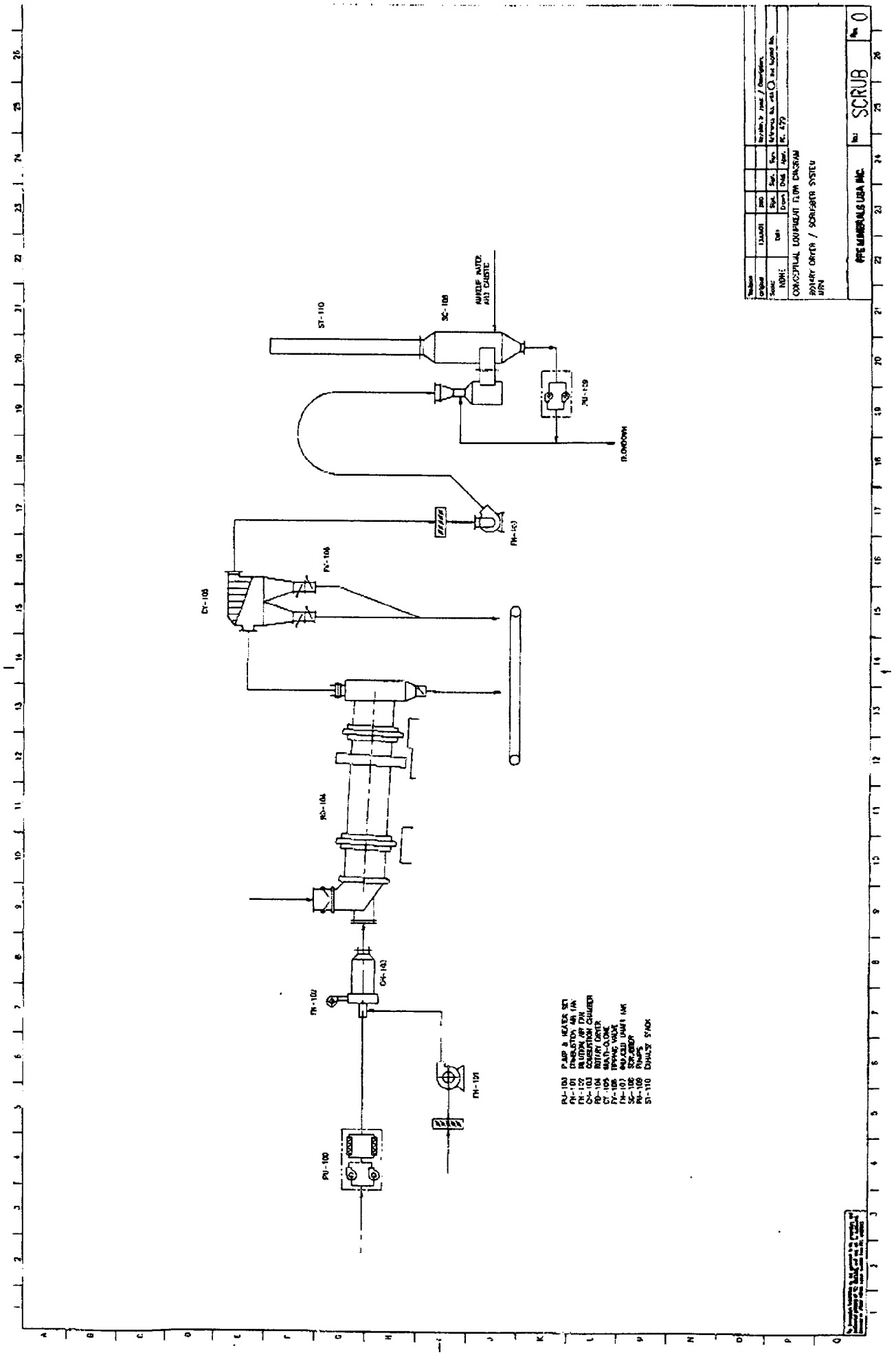


Particlulate Emission Control Multiclone-Scrubber / ESP																
Operating Temperature + Acid Dewpoint / - Acid Dewpoint																
Material Of Construction A36 / SS																
SO2 Stack Scrubbing Yes / No																
Target Achieved	No		No		No		No			No		No		No		No
Particulate		✓		✓		✓		✓	✓		✓		✓		✓	
SO2		✓		✓		✓		✓	✓		✓		✓		✓	
Low Capital Costs		+		o		+		o	o		-		+		-	
Low Fuel Costs		-		-		+		+	-		-		+		+	
Low Power Costs		-		-		-		-	+		+		+		+	
Low Maintenance Cost		+		+		-		+	+		+		-		+	
Case #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

✓ Achieved
\+ Strongly Achieved
o No Advantage
\- Strength Not Achieved

		MRN Gas Handling options Investment Analysis						
Fuel USD/ton	170							
Power USD/MW	75							
Caustic USD/Ton @ 73%	250			Preliminary.				
Design Fuel S %S	5							
days per year	330						Ceuston 13 June 01	
Case Number	2	4	6	8	9	11	13	15
Fuel ton hr	3.12	3.12	2.8	2.8	3.12	3.12	2.8	2.8
Caustic use t/hr	0.267123	0.267123	0.239726	0.239726	0.267123	0.267123	0.239726	0.239726
Fan Am3/hr	209000	209000	196000	196000	209000	209000	196000	196000
Fan mmwg	970	970	970	970	127	127	127	127
Fan kw operating	728.0349	728.0349	682.7505	682.7505	95.32004	95.32004	89.39104	89.39104
Initial Capital Cost Million USD								
ESP					0.70	1.70	0.70	1.70
Multiclone	0.19	0.50	0.19	0.50				
Scrubber	0.75	0.75	0.75	0.75				
Stack Scrubber					0.75	0.75	0.75	0.75
New transformer	0.03	0.03	0.03	0.03				
Thickener	0.19	0.19	0.19	0.19				
Total Initial Capital Costs	1.16	1.47	1.16	1.47	1.45	2.45	1.45	2.45
Incremental Capital Costs		-0.31		-0.31	-0.29	-1.29	-0.29	-1.29
Fuel Cost MUSD/yr	4.20	4.20	3.77	3.77	4.20	4.20	3.77	3.77
Power Cost MUSD/yr	0.43	0.43	0.41	0.41	0.06	0.06	0.05	0.05
Caustic Cost MUSD/yr	0.53	0.53	0.47	0.47	0.53	0.53	0.47	0.47
	*** Note cost of thickener effluent treatment not included ***							
Total Operational Costs	5.16	5.16	4.65	4.65	4.79	4.79	4.30	4.30
Incremental Operational Costs Savings in Million USD/yr			0.51	0.51	0.38	0.38	0.86	0.86
Maintenance Costs								
ESP Replace internals 1 x / 2 years							0.35	
Multiclone internal 2x year			0.04					
Scrubber 0								
Stack Scrubber 0								
Thickener 0								
Total Incremental Operational & Maintenance Costs Savings			0.47	0.51	0.38	0.38	0.51	0.86


caustic (option)
ST-109
FN-109
EP-103
FN-136
RO-104
CH-103
FN-102
FN-101
FN-110
PU-105 PUMP & HEATER SET
FN-101 COMBUSTION AIR FAN
FN-109 DILUTION AIR FAN
CH-103 COMPARTMENT
RO-104 ROTARY DRYER
EP-103 ELECTROSTATIC PRECIPITATOR
FN-102 ROTARY AIRLOCK
FN-110 INDUCED DRAFT FAN
ST-109 EXHAUST STACK
FFE MINERALS USA INC.
CONCEPTUAL EQUIPMENT FLOW DIAGRAM
ROTARY DRYER / ESP SYSTEM
ESP
0



Coal ash deposits were observed in the pilot combustion chamber following operation at 1950°F and 2050°F. The coal ash deposits, which were concentrated in the outlet cone section, represented up to 25% of the total coal ash input to the process. While the pilot results represent a worst case scenario due to the outlet restriction on the combustion chamber, the potential does exist for ash buildup in the commercial combustion chamber. It is recommended that lower operating temperatures (i.e. 1750°F if commercially viable) or the use of a slagging combustion chamber be further investigated at this time.

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OBJECTIVES

1. Establish baseline product quality, process emissions and combustion profile utilizing 100% natural gas firing and combustion chamber outlet temperatures of 1750°F, 2050°F and 2250°F.
2. Evaluate coal firing rates of 25%, 50%, 75% and 100% (100% is equivalent to 1.4 MMBtu/st trona feed) at a temperature of 2050°F. Evaluate product quality, emissions and the combustion profile.
3. Determine the emission of heavy metals (cadmium, lead, mercury and arsenic) at the filter outlet location when firing 100% natural gas and 100% coal.
4. Collect product samples to facilitate soluble silica and total organic carbon (TOC) analyses to be performed by Solvay.
5. Compare product quality, emissions and combustion profiles for natural gas and coal firing.

BACKGROUND

Solvay Minerals of Green River, Wyoming currently operates several natural gas fired rotary calciners for the production of soda ash from trona. They are currently evaluating the feasibility of converting these units to coal firing due to the significant increase in the price of natural gas experienced during the last year. Prior to converting their calciners for dual fuel firing, Solvay must address concerns regarding the potential for coal ash deposit formation in the combustion chamber and calciner gas inlet areas, the effect of coal ash on product quality, and the effect on emissions in terms of NO_x, CO, hydrocarbons and metals. This program was designed to provide a direct comparison of natural gas and coal firing in a pilot trona rotary calcination process in order to address the concerns outlined. Mr. David M. Hansen, Senior Process Engineer, and Mr. William E. Stuble, P.E., Process Engineer, of Solvay Minerals were present to observe the test program.

EQUIPMENT

18" x 12' Rotary Calciner:

A schematic of the 18" diameter by 12' long rotary calciner system is provided in Figure 1on Page 2. This schematic includes all primary components of the calciner system including air heater, rotary calciner, coal feed circuit and particulate filter, and indicates process sampling locations. See Figure 2 on Page 2 for a photograph of the rotary calciner.

The hot gas stream for the rotary calciner is generated using a direct-fired refractory-lined air heater connected to the gas inlet hood. Heat is generated by either 100% natural gas or a combination of natural gas and pulverized coal injected through a North American 6422-2 dual fuel burner. See Figure 3 on Page 3 for a photograph of the combustion chamber and burner, and Figure 11 on Page 24 in the Appendix for a schematic of the burner. The natural gas flow rate is controlled using a manual needle valve, and the flow rate is determined using a calibrated rotameter. The coal rate is controlled by a ¾" diameter

calibrated screw. The screw discharge enters an eductor circuit, which conveys the coal to the ½" diameter burner tube through a 1" diameter hose. The stainless steel burner tube replaces the oil nozzle in the dual fuel burner, and includes a 360° 16 gauge spiral insert in the tip to improve air/fuel mixing. The eductor airflow is measured using a calibrated rotameter.

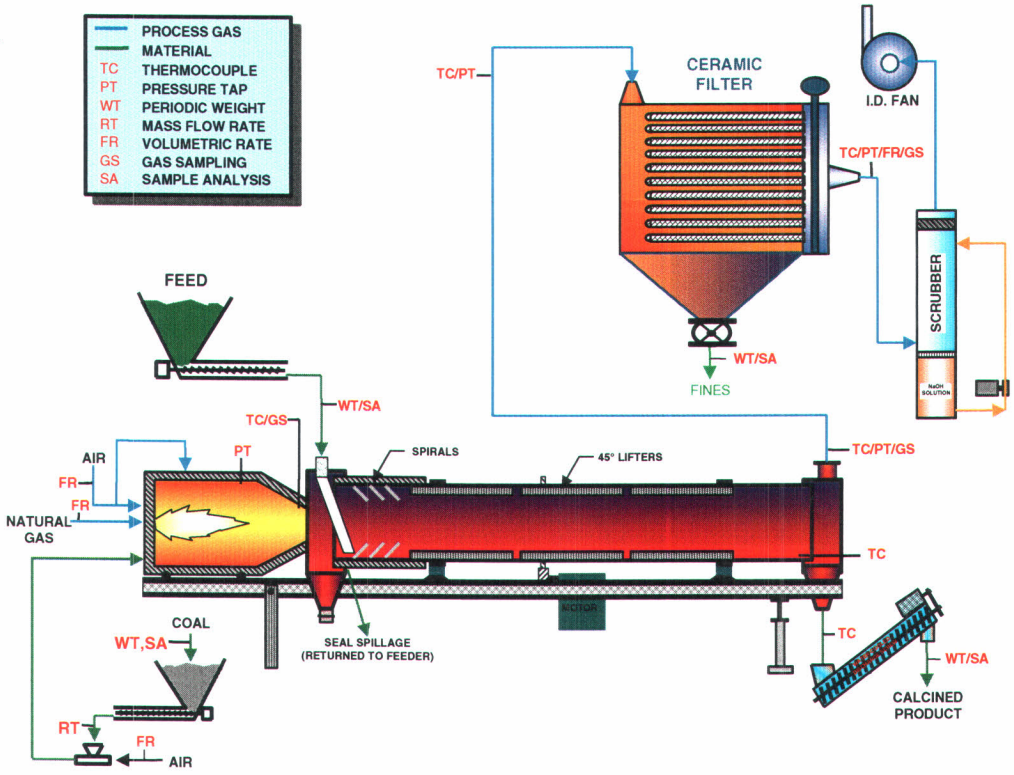


Figure 1: 18" x 12' Rotary Calciner Schematic

Figure 2: 18" x 12' Rotary Calciner System

The main air for the combustion chamber is supplied by a high-pressure blower, and the rate of flow is measured using a 4" averaging pitot tube. The distribution of main air to the burner and chamber is adjusted as required to control flame shape. Adjustments are generally made when flame carryover into the rotary calciner is observed.

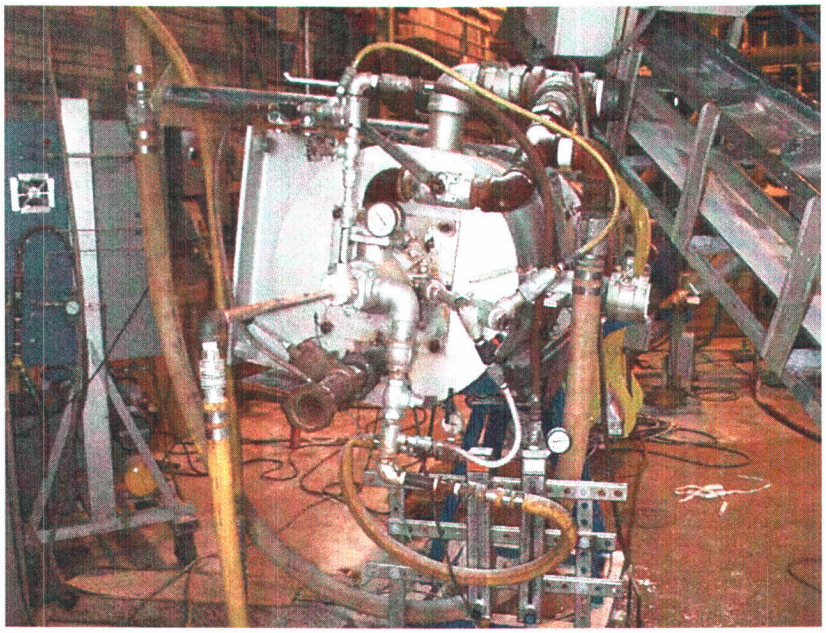


Figure 3: Combustion Chamber

The gas output from the air heater passes through the gas inlet hood and enters the 18" diameter by 12' long rotary calciner body. The cold feed enters the rotary via a 3" diameter pipe that extends through the gas inlet hood. The material and process gas stream flow in parallel through the calciner. A section of spirals is used at the feed inlet end of the calciner to push the material into the calciner and minimize dropout. The material then flows through three sets of 45° lifter sections (5 lifters per section) that extend to within two feet of the calciner discharge end. These lifters shower the material through the gas stream to improve heat transfer. See Figure 4 on Page 4 for a photograph of the calciner internals. The first three feet of the shell at the feed end is lined with a 2" thick layer of 70% alumina castable.

The material and process gas exit the calciner through the gas outlet/discharge hood. The material drops into an inclined screw conveyor and then discharged into a 55 gallon drum. The net weight of material in the drum is recorded when the drum is full using a calibrated scale. The process gas stream is directed through a high-temperature filter, wet scrubber, I.D. fan and stack. A damper positioned at the I.D. fan inlet is utilized to control the static pressure inside the calciner. Fines are discharged from the filter through a rotary valve and collected in a steel container. A six inch averaging pitot tube indicates the total gas flow rate at the filter exit.

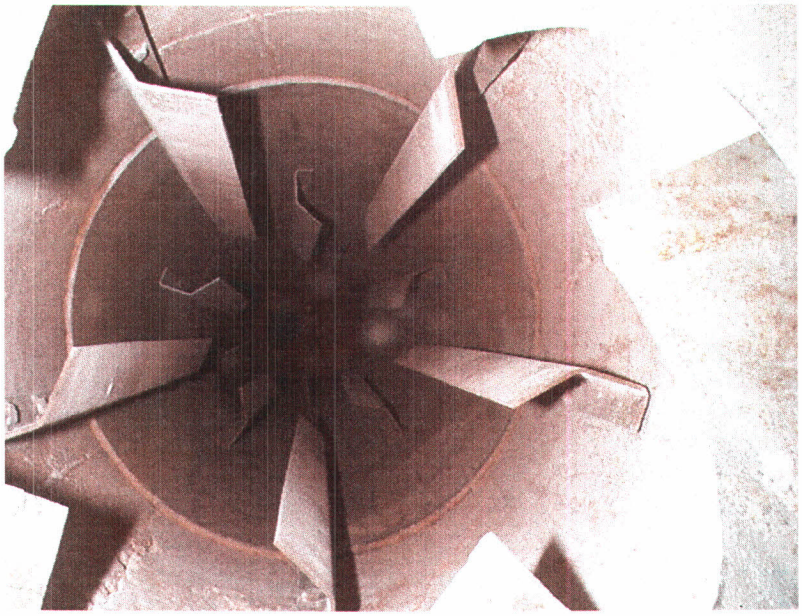


Figure 4: Calciner Internals

The feed rate is controlled using a variable-speed screw feeder. The feed rate is determined prior to the start of testing by collecting a sample from the screw discharge stream for a measured period of time, weighing the sample using a calibrated scale, calculating the corresponding hourly flow rate, and then generating a screw calibration curve.

Thermocouples indicate process temperatures at five locations across the calciner system (combustion chamber outlet, calciner off gas, load/spill, filter inlet and filter outlet). The temperatures indicated by these thermocouples are recorded every minute by the data acquisition system. Four dial thermometers indicate process gas temperatures along the calciner, and this data is manually recorded during steady operation. Pressure taps connected to U-tube manometers and pressure transducers indicate system pressures in "WG at five locations (combustion chamber, calciner feed hood, calciner discharge hood, filter inlet and filter outlet). The pressure transducer output is recorded every minute.

A Teledyne system is utilized to measure the concentration of oxygen, combustibles and carbon monoxide at the combustion chamber outlet and calciner exit locations. The analyzer outputs are connected to the data acquisition system, and this data is recorded every minute.

The ceramic filter off gas is analyzed to determine the concentrations of sulfur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, oxygen, total hydrocarbons and methane. The following analyzers are used: a Rosemount MLT4 (SO_2, CO, CO_2 and O_2), a Rosemount 951A (NO_x) and a JUM 109A (THC

and CH_4). All analyzer outputs are connected to the data acquisition system and recorded every minute.

A crushing circuit was added to calciner system to reduce the top size of the trona feed to 4 mesh. The crushing circuit included the following: 60" diameter vibrating screen unit with 4 mesh screen, a 12" diameter dual-roll crusher with a gap setting of 1/8", and three conveyor belts. See Figure 5 below for a photograph of the circuit.

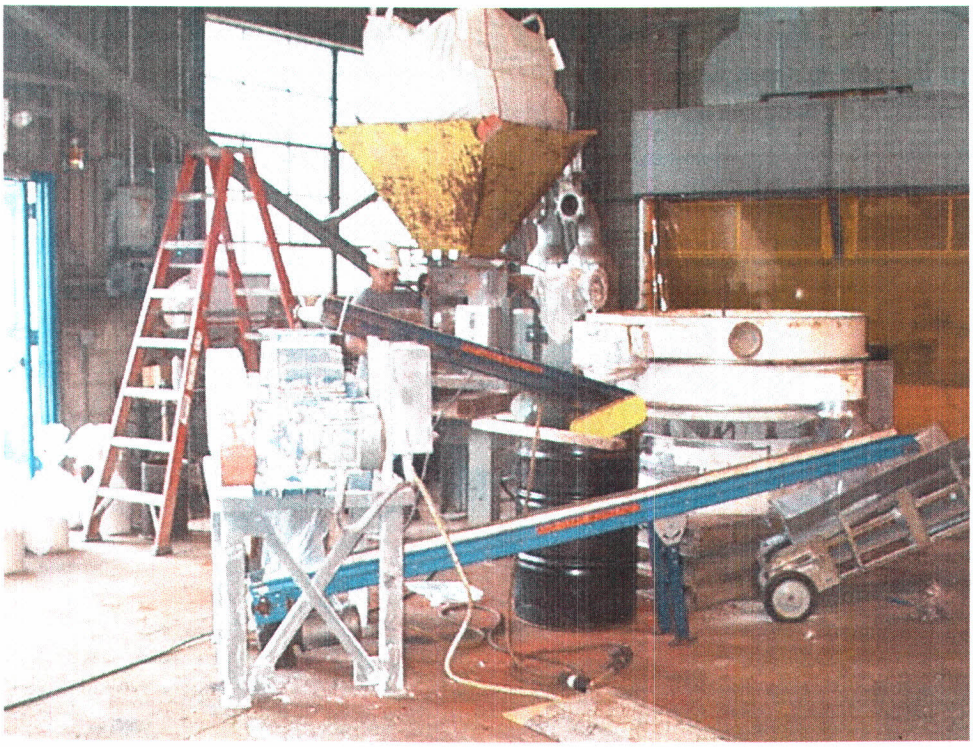


Figure 5: Roll Crushing Circuit

PROCEDURE

Twenty-one bags containing 42,000 pounds of trona (Lab #010747) and two bags containing 2,000 pounds of coal (Lab #010748) were received on 17Jul01. The trona was considered suitable in its as received state to be conveyed through the screw feeder in the calciner feed circuit. The coal was crushed to minus ½" and then ground in a heated, air-swept vertical roller mill. Half of the coal was ground to 80% passing 200 mesh and the remaining half was ground to 90% passing 200 mesh. The coal ground to 90% passing 200 mesh was utilized for the calciner program. It was noted during the mill operation that the mill differential pressure varied (differential pressure is used for capacity control), and was accompanied by a variation in the product particle size distribution.

Rotary Calciner Operation: The rotary calciner system and instrumentation were setup as described in the Equipment section of this report. All flow rates, material weights, temperatures, pressures and gas compositions were measured

using calibrated instrumentation. This data was periodically entered into a spreadsheet. Temperature, pressure and gas analysis data were recorded in 60-second increments using the data acquisition equipment. The trona and ground coal feed rates were determined using 5-point calibration curves generated prior to the start of the program. A log was maintained to record observations and system adjustments made during pilot testing.

Composite feed samples were collected during each day of testing at the inlet and outlet of the crushing circuit. The weight of each sack of feed and time added to the screw feeder was recorded. The calciner discharge drums were weighed when fell. The filter fines weight was recorded every 30-60 minutes.

Phase 1: 1545 hr – 1800 hr, 14Aug:

Objective: Rotary calcine trona using natural gas firing and a combustion chamber temperature of 2050°F. Collect product samples, measure gaseous emissions and measure metals emissions.

The natural gas fired burner was ignited at 0625 hr on 13Aug, and the total airflow was set to 200 scfm. The calciner speed was set to 3.5 rpm to provide a material retention time of about 15 minutes. The combustion chamber temperature was slowly increased to approximately 1500°F, and then the feed system was started at 0730 hr. Poking was required during the next 2.5 hours to maintain material flow to the screw. A stable feed rate without poking was obtained by 1000 hr using air pads and a vibrator. The feed rate was adjusted to obtain a spill temperature of 300-325°F.

Analysis of a product sample collected at 1030 hr indicated a high bicarb level. The calciner speed was slowed to 3.15 rpm and the spill temperature was increased to 350°F. These adjustments were not accompanied by a reduction in the bicarb level. The calciner slope was reduced from ¼"/ft to 1/8"/ft at 1217 hr to double the retention time to about 30 minutes. Product bicarb levels remained high.

The combustion chamber temperature was increased to 2250°F at 1430 hr, and the feed rate was increased to hold the spill temperature at 350°F. This did not reduce the product bicarb level, which remained above 5%. The test conditions used for the Tenneco study in 1990 were applied to the calciner operation (5 rpm, ¼"/ft slope and 100 scfm airflow). Product bicarb levels remained above 5% following these changes. The calciner was shutdown at 1746 hr. It was decided to install a roll crushing circuit to reduce the feed top size to 4 mesh. The uncalcined core present in the larger particles suggested that a reduced feed top size would significantly improve calcination.

The roll crushing circuit was installed beginning at 0600 hr on 14Aug. The natural gas burner was ignited at 0852 hr, and the feed system was started at 1059 hr. Total airflow was set to 100 scfm and the calciner speed was set to

3.15 rpm. A spill temperature of 350°F was established using a feed rate of 500 lb/hr. Product bicarb levels were greater than 5%. It was agreed to increase the spill temperature to 400°F.

The target spill temperature was obtained by reducing the feed rate to 345 lb/hr. The increase in the spill temperature to 400°F was accompanied by a reduction in the product bicarb level to <0.5%. Heavy metals sampling was begun at 1545 hr at the filter exit. This sampling was completed at 1800 hr. Calciner operation was very stable between the period of 1545-1800 hr.

The product temperature was measured at the inlet to the cooling screw at 1624 hr using an open end Type K thermocouple. A material temperature of 320°F was measured.

Phase 2: 1830 hr – 1930 hr, 14Aug:

Objective: Rotary calcine trona using natural gas firing and a combustion chamber temperature of 2250°F. Collect product samples and measure gaseous emissions.

Adjustments were made to the burner at 1800 hr to increase the combustion chamber to 2250°F. Stable operation with the target combustion chamber and spill temperatures were obtained by 1830 hr. Stable operation was maintained until the conclusion of the phase at 1930 hr. The system was shutdown at 1930 hr. The calciner inventory was weighed, and a sample of the scrubber liquor was collected. The scrubber liquor was drained and replaced with city water.

Phase 3: 0830 hr – 1030 hr, 15Aug:

Objective: Rotary calcine trona using 25% coal firing (0.35 MMBtu/st feed) and a combustion chamber temperature of 2050°F. Collect product samples and measure gaseous emissions.

The natural gas fired burner was ignited at 0625 hr on 13Aug, and the total airflow was set to 100 scfm. The calciner speed was set to 3.15 rpm to provide a material retention time of about 17 minutes. The combustion chamber temperature was slowly increased to approximately 1200°F, and then the feed system was started at 0703 hr. The natural gas burner was adjusted to increase the chamber temperature to 2000°F, and then the coal feeder was started at 0804 hr at a rate of 5.5 lb/hr. The flame appeared to be fully contained within the combustion chamber and, therefore, no adjustments to air distribution were required.

The feed rate was adjusted within the range of 390-467 lb/hr to maintain a load temperature of 400-425°F. The coal was also adjusted within the range of 5.5-6.8 lb/hr to maintain the coal addition rate of 0.35 MMBtu/st. Small adjustments were made to the natural gas rate during the phase to hold a combustion chamber temperature of 2050°F. The phase was concluded at 1030 hr following

two hours of steady operation. No ash deposits were visible in the combustion chamber outlet cone area.

Phase 4: 1045 hr – 1200 hr, 15Aug:

Objective: Rotary calcine trona using 50% coal firing (0.70 MMBtu/st feed) and a combustion chamber temperature of 2050°F. Collect product samples and measure gaseous emissions.

The coal rate was increased to 11.4 lb/hr at 1035 hr to obtain a coal input of 0.70 MMBtu/st feed, and the natural gas rate was reduced to hold a combustion chamber temperature of 2050°F. Due to the increased NO_x emission rate, the range on the NO_x analyzer was increased from 0-100 ppm to 0-250 ppm. Calciner operation was considered stable immediately following the coal rate adjustment. Three sets of product samples were collected (1100 hr, 1130 hr and 1200 hr), and then the phase was concluded at 1200 hr. No deposits were observed in the combustion chamber.

Phase 5: 1215 hr – 1330 hr, 15Aug:

Objective: Rotary calcine trona using 75% coal firing (1.05 MMBtu/st feed) and a combustion chamber temperature of 2050°F. Collect product samples and measure gaseous emissions.

The coal rate was increased to 16.4 lb/hr at 1203 hr to obtain a coal input of 1.05 MMBtu/st feed, and the natural gas rate was reduced to hold a combustion chamber temperature of 2050°F. Following the reduction in the natural gas flow, the rate was below the range of the rotameter. Therefore, the natural gas rate entered into the process spreadsheet for Phase 5 was estimated. A lower range rotameter was installed before the start of Phase 6.

Stable operating conditions were obtained by 1215 hr, and maintained until the conclusion of the phase at 1330 hr. The more radiant flame formed at the 75% coal firing rate made it more difficult to view the combustion chamber refractory surface for deposit formation. However, there were no obvious deposits present in the chamber following the completion of the phase.

Phase 6: 1400 hr – 1635 hr, 15Aug:

Objective: Rotary calcine trona using 100% coal firing (1.40 MMBtu/st feed) and a combustion chamber temperature of 2050°F. Collect product samples, and measure gaseous and heavy metals emissions.

The coal rate was increased to 21.9 lb/hr at 1335 hr to obtain a coal input of 1.40 MMBtu/st feed, and the natural gas rate was reduced to hold a combustion chamber temperature of 2050°F. The flame intensity increased significantly following the coal rate increase. Calciner operation was stable throughout the phase. Following the completion of the phase and reduction in the coal rate, ash deposits could be seen on the combustion chamber cone.

The product temperature at the cooling screw inlet was measured at 1350 hr. A maximum temperature of 340°F was measured. The filter off gas was sampled between 1430 hr and 1630 hr to determine the emission of heavy metals from the process.

Phase 7: 1640 hr – 1837 hr, 15Aug:

Objective: Rotary calcine trona using 100% coal firing (1.40 MMBtu/st feed) and a combustion chamber temperature of 1750°F. Collect product samples and measure gaseous emissions.

The coal and natural gas rates were decreased at 1640 hr to reduce the combustion chamber temperature to 1750°F, and the trona feed rate was reduced to 275 lb/hr to hold the load temperature at 400-425°F. The feed rate was further reduced to 265 lb/hr at 1655 hr followed by a reduction in the coal rate to 15.25 lb/hr. These rates were maintained until the conclusion of the phase at 1837 hr.

Following the completion of Phase 7, the natural gas flow was gradually decreased while increasing the coal rate to hold 1750°F. A stable coal flame and combustion chamber temperature were established following a complete stoppage of natural gas flow. This coal firing only evaluation was completed at 1900 hr. A sample of scrubber liquor was collected after the system was shutdown.

The combustion chamber was removed after the system had cooled overnight. Nearly two pounds of ash were removed form the chamber; mainly from the cone section. The chamber was photographed prior to ash removal and collection. Samples of buildup were also collected from the feed pipe and spirals located inside of the calciner.

Phase 8: 0915 hr – 1115 hr, 16Aug:

Objective: Rotary calcine trona using 100% coal firing (1.40 MMBtu/st feed) and a combustion chamber temperature of 1950°F. Determine if the lower temperature prevents deposit formation. Collect product samples and measure gaseous emissions.

The natural gas fired burner was ignited at 0743 hr on 16Aug, and the total airflow was set to 100 scfm. The calciner speed was set to 3.15 rpm to provide a material retention time of about 17 minutes. The combustion chamber temperature was increased to approximately 1000°F, and then the feed system was started at 0755 hr. The natural gas burner was adjusted to increase the chamber temperature to 1950F, and then coal feeder was started at 0848 hr. The feed rate was adjusted within the range of 415-505 lb/hr to maintain a load temperature of 400-425°F, and the coal rate was adjusted in the range of 24.3-29.6 lb/hr to hold the 100% coal firing rate.

The phase was concluded at 1115 hr. Ash deposits could be seen in the combustion chamber.

Phase 9: 1135 hr – 1300 hr, 16Aug:

Objective: Rotary calcine trona using 100% natural gas firing, a combustion chamber temperature of 2050°F, and a 375°F load temperature. Determine if the reduced load temperature is accompanied by an increase in the product bicarb level to >0.

The coal feeder was turned off at 1115 hr, and then the natural gas flow rate was increased to bring the combustion chamber temperature up to 2050°F. The feed rate was increased to 600 lb/hr to reduce the load temperature to 375°F. The feed rate was decreased to 570 lb/hr at 1143 hr to hit the target load temperature. The phase was concluded at 1300 hr.

Phase 10: 1315 hr – 1430 hr, 16Aug:

Objective: Rotary calcine trona using 100% natural gas firing, a combustion chamber temperature of 1750°F, and a 400-425°F load temperature. Collect product samples and measure emissions.

The natural gas flow rate and feed rate were decreased at 1300 hr. A feed rate in the range of 298-382 lb/hr was required to control the load temperature. The phase was concluded at 1430 hr following over an hour of steady operation.

The combustion chamber was cooled overnight and then removed for inspection. The chamber was photographed and then approximately one pound of ash was removed.

RESULTS & DISCUSSION

A laboratory study was conducted in May01 to evaluate coal composition, coal ash fusion and ash chemistry. The study included a series of muffle furnace burns on a mixture of trona with and without coal ash to determine the affect of coal ash on overall product solubility and silica solubility. The coal ash addition was based on a commercial calciner specific fuel consumption of 1.4 MMBtu/st trona. The test summary issued on 17May01 is included in the Appendix (Pages 93-100). The most notable results from the study includes an initial ash deformation temperature of 2100°F. Based on this study, the maximum calciner inlet temperature should be limited to <2100°F to minimize the potential for ash deposition in the combustion chamber.

A second laboratory study was conducted in Aug01 to evaluate the potential for reactions between mixtures of trona/coal ash (90/10 and 95/5 ratios) and magnesium brick (Narmag 98B manufactured by North American Refractories Company) when fired in a muffle furnace at temperatures between 2230-2500°F. The following procedure was utilized for the study: (1) preheat brick in muffle furnace at temperature for 15 minutes, (2) remove brick and immediately place

sufficient material to fill slot in brick, (3) place sample back in furnace for 15 minutes, (4) remove sample and observe/photograph brick samples and (5) slice brick sample and observe/photograph material penetration into brick. Photographs of the brick samples are included in Figure 12 and Figure 13 in the Appendix (Pages 25 and 26). Table 1 below summaries the qualitative results obtained from this study.

Table 1: Laboratory Brick Test Summary

Test #	%Coal Ash	%Trona	Temperature-°F	Observations
1	95	5	2230	No reaction w/ brick. Sample slightly fused. Released from brick upon cooling.
2	95	5	2500	Material liquified. Slight penetration into brick.
3	90	10	2270	Material melted and popped upon cooling. No penetration into brick.
4	90	10	2500	Material liquified. Slight penetration into brick.
5	0	100	2300	Material liquified and penetrated up to 1/2" into brick.
6	0	100	2500	Material liquified and penetrated up to 1/2" into brick.
7	100	0	2300	Material slightly fused and minor sticking to brick. Full release from brick upon cooling.
8	100	0	2500	Material melted and popped upon cooling. Minor penetration into brick.

The laboratory brick tests indicate that the presence of trona in the coal ash will reduce the melting point of the mixture. However, there are no apparent reactions between the mix and the magnesium brick at temperatures of 2300°F and lower. As the temperature is further increased and the material completely liquefies, there is a small degree of penetration into the brick.

The coal sample provided by Solvay was ground to 80% passing 200 mesh and 90% passing 200 mesh in an air-swept vertical roller mill. The finer grind was produced following a shakedown test in the rotary calciner that demonstrated coal particle combustion inside the calciner when injecting the 80% minus 200 mesh sample. The sample ground to 90% passing 200 mesh was utilized for all test phases that included coal firing.

A roller mill off gas temperature of 200°F was maintained to reduce the moisture content from 19% to approximately 8%. The resulting ground coal was considered free flowing. Despite the free-flowing nature of the ground coal, the mill pressure drop was found to be unstable, which suggests poor material flow in

the mill, particularly in the separator area. A higher mill outlet gas temperature is suggested to further reduce the product moisture content in an attempt to improve mill stability.

Proximate, ultimate and ash composition analyses were performed on the coal sample received for the laboratory evaluation. See Page 94 in the Appendix for analysis results. These analyses were utilized to calculate the coal's net heating value (11,952 Btu/lb), air requirement for complete combustion and products of combustion (see Table 6 on Page 27 in the Appendix). The bulk coal sample provided for the calciner test was also submitted for proximate, ultimate and ash composition analyses. These results will be provided in a supplement report. Figure 14 and Table 7 on Pages 28-29 in the Appendix include a complete laser particle size distribution for the finer coal grind used for the calciner program. The coal sample was approximately 85% passing 200 mesh with a moisture content of 8.23% and a bulk density of 30.8 lb/cf. The coal's Hardgrove Index was 48.6.

Rotary calciner testing was performed between the dates of 13-16Aug. See the Equipment section for a complete description of the calciner system. Table 2 on Page 13 includes a summary of the test conditions evaluated and average operating data. Table 8-Table 19 in the Appendix (Pages 30-41) include all operating data recorded during stable operation. Figure 15 - Figure 30 in the Appendix (Pages 42-57) include system temperature profiles, system pressure profiles, Teledyne analyzer data profiles (O_2, CO and combustibles) and filter exit gas analysis.

Initial calciner operation was performed using a load temperature of 300-325°F and a material retention time of 15 minutes. These conditions yielded product bicarb levels greater than 5%. An increase in the material retention time to 30 minutes was not accompanied by a reduction in the product bicarb levels. It was observed that the coarse product particles contained a core of uncalcined trona. Therefore, a roll crushing circuit was installed the morning of 14Aug to reduce the feed top size from 5/16" to 4 mesh in an attempt to improve calcination. Subsequent testing performed using the initial conditions noted above (a load temperature of 300-325°F and a material retention time of 15 minutes) and a minus 4 mesh feed did not produce a product with a bicarb level <1%. An increase in the load temperature to 400-425°F was required to achieve complete calcination. This load temperature and a 17 minutes material retention time were used for all test phases.

Calciner product and filter fines samples representing stable operating conditions during each phase were analyzed by FFE Minerals for residual bicarbonate using the Solvay Method. A full description of the method is included in Table 51-Table 53 on Pages 101-103in the Appendix. See Table 3 on Page 14 for a complete listing of all sample bicarb analyses. All samples analyzed by FFE Minerals were

shipped to Solvay for further analysis including total organic carbon and soluble silica.

Calciner product bicarb levels were below detectable levels for all phases except for Phase 9. Phase 9 included a targeted reduction in the load temperature to 375°F to determine if the 400-425°F load temperature was over-calcining the material. As the Phase 9 bicarb levels increased to >1%, it was concluded that the use of a 400-425°F load temperature was not over-calcining.

Two possible explanations are offered as for the reason that a higher load temperature was required to achieve full calcination: (1) the load probe was indicating an artificially high material temperature or (2) the inefficiency of the pilot calciner necessitated a higher material temperature. Periodic measurements of the product stream temperature at the inlet to the discharge screw did indicate a material temperature of 325-350°F when the load probe was indicating a temperature of 400°F.

Table 2: Rotary Calciner Test Summary

Phase	Date	Time	Fuel[1]	Calciner			Total Fuel[2]	Coal			Natural Gas			Feed	Product	
				Inlet °F	Out °F	Load °F	MMBtu/st	lb/hr	MMBtu/st	%total	scfm	MMBtu/st	%total	lb/hr	lb/hr	%tota
1	14-Aug	1545-1800	Gas	2087	507	406	2.15	0.0	0	0	6.7	2.15	100	345	227	88.3
2	14-Aug	1830-1930	Gas	2260	515	409	1.66	0.0	0	0	6.9	1.66	100	460	265	88.2
3	15-Aug	0830-1030	25% Coal	2051	541	415	1.85	6.0	0.35	18.9	5.6	1.50	81.1	412	221	89.3
4	15-Aug	1045-1200	50% Coal	2056	526	401	2.11	10.9	0.70	33.1	4.7	1.41	66.9	373	219	89.3
5	15-Aug	1215-1330	75% Coal	2056	527	407	2.25	16.4	1.05	46.7	4.0	1.20	53.3	373	215	88.7
6	15-Aug	1400-1635	100% Coal	2058	525	403	2.44	21.9	1.40	57.5	3.5	1.04	42.5	373	219	87.8
7	15-Aug	1640-1837	100% Coal	1756	504	402	2.61	15.3	1.40	53.8	2.8	1.21	46.2	260	168	87.3
8	16-Aug	0915-1115	100% Coal	1941	511	401	2.22	24.9	1.40	63.1	3.1	0.82	36.9	425	264	89.8
9	16-Aug	1135-1300	Gas	2059	503	372	1.59	0.0	0	0	8.3	1.59	100	579	306	90.4
10	16-Aug	1315-1430	Gas	1764	501	398	2.06	0.0	0	0	6.6	2.06	100	355	205	91.1

Phas	Fines		Retention Time[3]	Total Air	Combustion Chamber			Filter Exit Emissions						Sample Analysi	Average Bicarb
								NOx		CO		THC			
	lb/hr	%total	minutes	scfm	%O2	%Com	ppmCO	ppm	lb/st	ppm	lb/st	ppm	lb/st	Time	%
1	30	11.67	16.7	108	5.6	0.11	29	20	0.17	34	0.18	15	0.13	[illegible]	0
2	35.4	11.78	16.7	105	3.3	0.11	48	28	0.18	40	0.15	14	0.08	1900,193	0
3	26.4	10.66	16.7	102	4.2	0.09	140	95	0.72	63	0.27	14	0.09	1000,103	0
4	26.2	10.69	16.7	98	4.5	0.09	192	144	1.15	79	0.39	14	0.11	1130,120	0
5	27.5	11.34	16.7	105	4.8	0.09	337	172	1.38	61	0.30	13	0.10	1300,133	0
6	30.6	12.24	16.7	105	4.8	0.31	533	185	1.49	65	0.32	13	0.10	1500,153	0
7	24.47	12.70	16.7	105	9.0	0.08	635	159	1.93	27	0.20	9	0.11	1800,183	0
8	29.96	10.20	16.7	102	7.0	0.12	1095	218	1.54	77	0.33	17	0.11	1030,110	0
9	32.6	9.60	16.7	104	6.3	0.07	148	41	0.20	74	0.21	22	0.10	1230,130	>2.5
10	20.2	8.90	16.7	102	9.2	0.11	187	21	0.18	23	0.12	13	0.10	1400,143	0

Table 3: Sample Bicarb Analyses

Date	Phase	Time	Anal.#	Lab#	Sample	NaHCO3
4/10	n/a	n/a	C010342	010330	Trona Feed	33.18
8/13	n/a	1100	C010947	010747	Product	> 5.04
8/13	n/a	1230	C010948	010747	Product	> 4.15
8/13	n/a	1400	C010949	010747	Product	> 9.53
8/13	n/a	1400	C010951	010747	Fines	0.00
8/13	n/a	1430	C010950	010747	Product	> 4.16
8/13	n/a	1430	C010952	010747	Product (-4 mesh)	> 4.19
8/13	n/a	1430	C010953	010747	Product (-8 mesh)	>4.19
8/13	n/a	1730	C010959	010747	Fines	0.00
8/13	n/a	1744	C010958	010747	Product	> 4.17
8/14	n/a	1250	C010960	010747	Product	> 4.17
8/14	n/a	1400	C010961	010747	Product	> 4.19
8/14	n/a	1500	C010962	010747	Product	0.42
8/14	1	1530	C010964	010747	Product	0.00
8/14	1	1630	C010965	010747	Product	0.00
8/14	1	1700	C010974	010747	Product	0.00
8/14	1	1730	C010975	010747	Product	0.00
8/14	1	1730	C010971	010747	Fines	0.00
8/14	2	1900	C010976	010747	Product	0.00
8/14	2	1930	C010977	010747	Product	0.00
8/14	2	1930	C010972	010747	Fines	0.00
8/15	3	0930	C010973	010747	Product	0.00
8/15	3	1030	C010980	010747	Product	0.00
8/15	3	1030	C010978	010747	Fines	0.00
8/15	4	1130	C010981	010747	Product	0.00
8/15	4	1200	C010982	010747	Product	0.00
8/15	4	1200	C010983	010747	Fines	0.00
8/15	5	1300	C010984	010747	Product	0.00
8/15	5	1330	C010985	010747	Product	0.00
8/15	5	1330	C010986	010747	Fines	0.00
8/15	6	1500	C010987	010747	Product	0.00
8/15	6	1530	C010988	010747	Product	0.00
8/15	6	1600	C010989	010747	Product	0.00
8/15	6	1630	C010991	010747	Product	0.00
8/15	6	1630	C010990	010747	Fines	0.00
8/15	7	1800	C010992	010747	Product	0.00
8/15	7	1830	C010993	010747	Product	0.00
8/15	7	1830	C010994	010747	Fines	0.00
8/16	8	1030	C010995	010747	Product	0.00
8/16	8	1100	C010996	010747	Product	0.00
8/16	8	1100	C010997	010747	Fines	0.00
8/16	9	1230	C010998	010747	Product	0.84
8/16	9	1300	C010999	010747	Product	> 4.15
8/16	9	1300	C011000	010747	Fines	0.00
8/16	10	1400	C011001	010747	Product	0.00
8/16	10	1430	C011002	010747	Product	0.00
8/16	10	1430	C011003	010747	Fines	0.00

The combustion chamber and burner configuration used for this study developed a flame that was retained within the combustion chamber. This observation applies to both natural gas and coal firing regardless of fuel rate or combustion chamber temperature. As would be expected, the injection of coal yielded a more luminous flame as compared to 100% natural gas firing. Flame intensity increased as the rate of coal injection was increased from 25% to 100%. From an operational standpoint, stable calciner operation with good temperature control was attained during all test phases.

Coal rates ranging from 25-100% were evaluated during this program. The 100% coal firing rate corresponds to a combustion rate of 1.4 MMBtu/st trona. As the pilot calciner specific fuel consumption was typically about 2 MMBtu/st, all coal firing test phases were supplemented with natural gas to achieve the target combustion chamber temperature. This mode of coal firing was selected to ensure that the effect of coal ash on product chemistry would be representative of the commercial calciner process. The effect of the coal ash on product chemistry and soluble silica levels is being determined by Solvay.

Coal ash deposits were observed in the combustion chamber following coal firing on 15Aug and 16Aug. These soft deposits were concentrated on the chamber outlet cone. See Figure 6 - Figure 7 for photographs of the ash deposits.

Figure 6: Combustion Chamber Ash Deposits-15Aug

Figure 7: Combustion Chamber Ash Deposits-16Aug

The total ash collected from the combustion chamber on 15Aug and 16Aug was weighed and compared to the total ash introduced to the system with the coal. The 1.88 pounds of ash collected on 15Aug represents 17% of the total ash in the coal processed. The 1.07 pounds of ash collected on 16Aug represents 25.2% of the total ash in the coal processed. These percentages suggest the potential for significant ash deposition in the commercial combustion chamber. The ash deposition observed in this program should be considered a worst case scenario given the restrictive outlet geometry in the pilot chamber (12" I.D. body x 6" I.D. outlet, see Figure 8 for profile) versus the commercial chamber geometry. Further consideration should be given to the slagging coal combustion system as it will eliminate potential ash buildup problems and ash effects on the product.

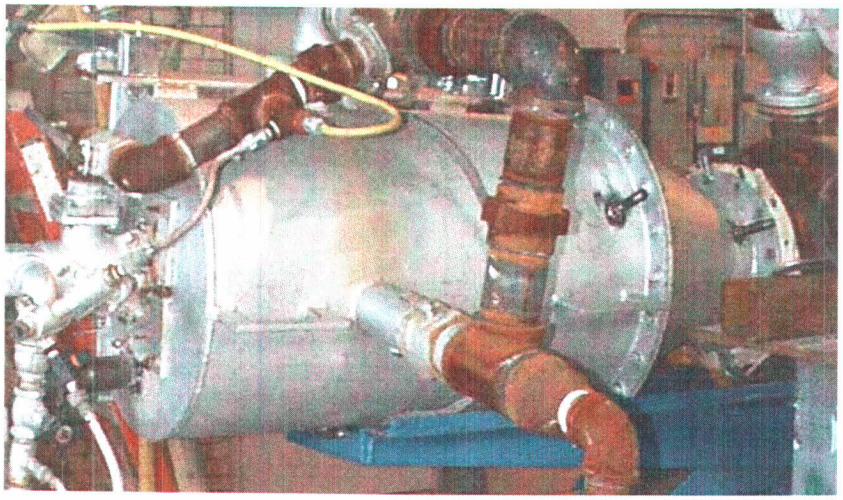


Figure 8: Pilot Combustion Chamber Profile

The ash deposit samples collected from 15Aug and 16Aug are being analyzed via x-ray fluorescence to determine their complete oxide composition. These analyses will be distributed in a supplement report.

An overall material balance was formulated for the pilot calciner operation (see Table 4 below). This balance indicates the following production balance: 1 pound of trona feed = 0.6154 pounds of calciner product + 0.0743 pounds of filter fines.

Table 4: Overall Material Balance

MATERIAL IN	Pounds	Loss-Free Pounds
Trona Feed @ 0.29% H2O/30% Loss	17072.0	11915.7
Coal @ 8.32% H2O/92.39% Loss	218.8	15.3
TOTAL MATERIAL IN	~~17290.8~~	~~11931.0~~
MATERIAL OUT	**Pounds**	**Loss-Free Pounds**
Calciner Product @ 0% Loss	10505.4	10505.4
Baghouse Fines @ 0% Loss	1268.0	1268.0
TOTAL MATERIAL OUT	~~11773.4~~	~~11773.4~~
Loss-free difference between material in and material out:	-1.32%	
~~Rotary Calciner System Production Distribution:~~		
	89.23% Calciner Product	
	10.77% Baghouse Fines	

The overall calcined material split between the calciner discharge and filter fines streams is as follows: 89.23% calciner product + 10.77% filter fines. Splits specific to each test phase are included in Table 2 on Page 13.

A total air input of approximately 100 scfm was utilized for all test phases. A higher airflow rate of 150-200 scfm was initially planned, but the rate was reduced in order to reduce calciner capacity and limit calciner material loading to the range of 4-8%. This total air input coupled with leakage through the hood seals and feed pipe generated a calciner exit gas velocity of 3.4 – 4.2 fps.

The emission rates of heavy metals (As, Cd, Hg and Pb) were determined at the filter exit during Phase 1 (100% natural gas @ 2050°F) and Phase 6 (100% coal @ 2050°F). The results of the Method 29 sampling procedure are included in

Table 5 below. See Table 20 on Page 58 in the Appendix for metals concentrations and rate calculations. A comparison of the emission rates during the two phases suggest does not provide evidence that metals emissions at the stack will be higher when firing coal.

Table 5: Metals Emission Summary

Metal	Phase 1 Natural Gas lb/hr	Phase 1 Natural Gas lb/st trona	Phase 6 Coal lb/hr	Phase 6 Coal lb/st trona	Difference %
As	2.74E-06	1.59E-05	3.32E-06	1.78E-05	12.11
Cd	5.63E-07	3.27E-06	1.18E-07	6.33E-07	-80.61
Hg	8.84E-07	5.12E-06	4.47E-07	2.40E-06	-53.19
Pb	6.24E-05	3.62E-04	1.78E-05	9.53E-05	-73.65

The filter off gas stream was sampled continuously to determine the emission concentration and rates of NO_x, SO_2, CO, CO_2, O_2, THC's and CH_4. The emission concentration profiles are included in Figure 27 - Figure 30 in the Appendix (Pages 54-57). Emission concentration data and calculated emission rates of NO_x, SO_2, CO, THC's and CH_4 (lb/hr and lb/st trona) are included in Table 8 - Table 19 in the Appendix (Pages 30-41), and the emission rates of NO_x, CO and THC's (lb/st trona) are summarized in Table 2 on Page 13. It should be noted that all NO_x emission rates are reported in terms of NO_2.

The emission rate of THC's ranged between 0.08-0.13 lb/st during the program. There was no distinction in the THC emission rate associated with fuel type or combustion chamber temperature. The emission rate of CO was generally higher (0.20-0.39 lb/st) during coal firing versus natural gas firing (0.12-0.21 lb/st). Improvements to coal burner design and operation would be expected to reduce CO emissions during coal firing to a level comparable to natural gas firing.

The most notable change in the process emission profile is associated with NO_x emissions when switching from 100% gas firing to 100% coal firing. The NO_x emission rate when firing 100% natural gas at approximately 2050°F averaged 0.19 lb/st. This rate increased by nearly 700% to 1.49 lb/st when firing 100% coal at a combustion chamber temperature of 2050°F. This higher NO_x emission rate is attributed to the nitrogen present in the coal (1.68%) and the significant increase in flame intensity. The use of a dual zone, low NO_x coal burner is recommended to limit flame intensity and NO_x formation. It should be noted that the NO_x emission rate per short ton of trona feed is likely greater than the commercial emission level due to the higher specific fuel consumption of the pilot calciner system.

Figure 9 and Figure 10 on the following page illustrate the emission of NO_x, CO and THC versus the coal firing rate, and the emission of NO_x, CO and THC versus the combustion chamber temperature.

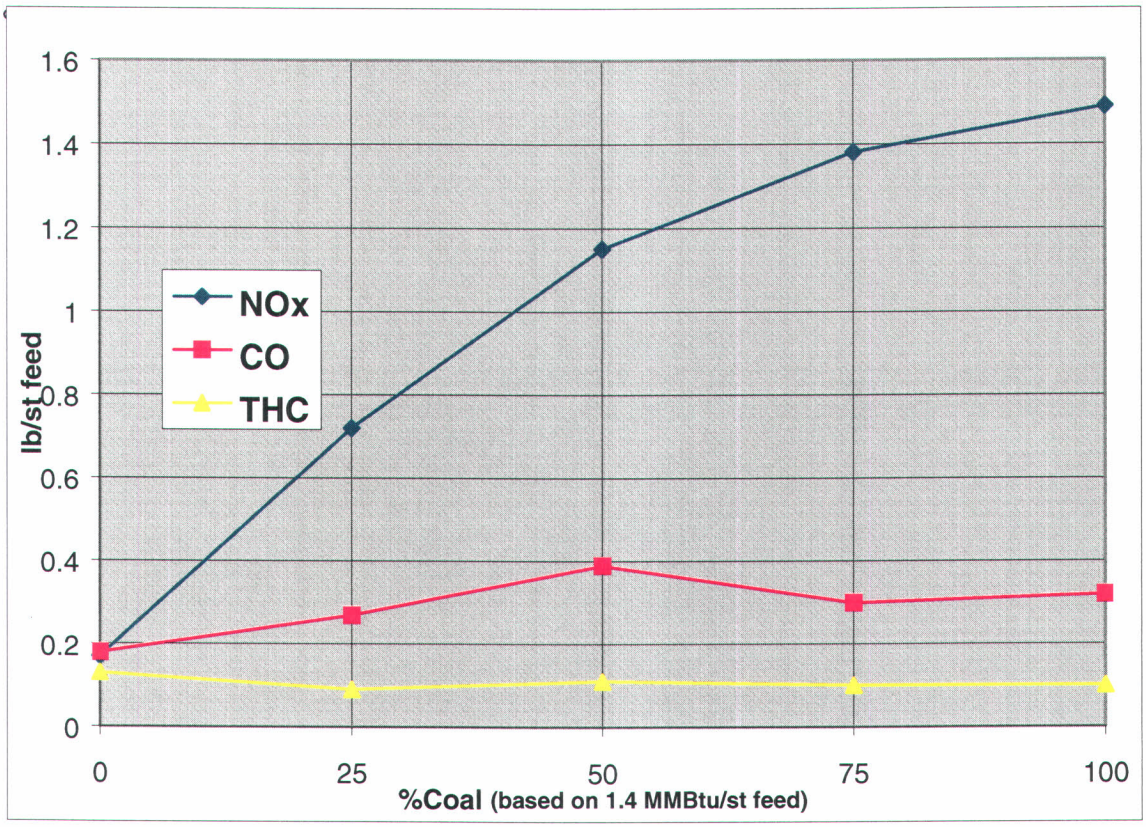


Figure 9: Emissions vs %Coal

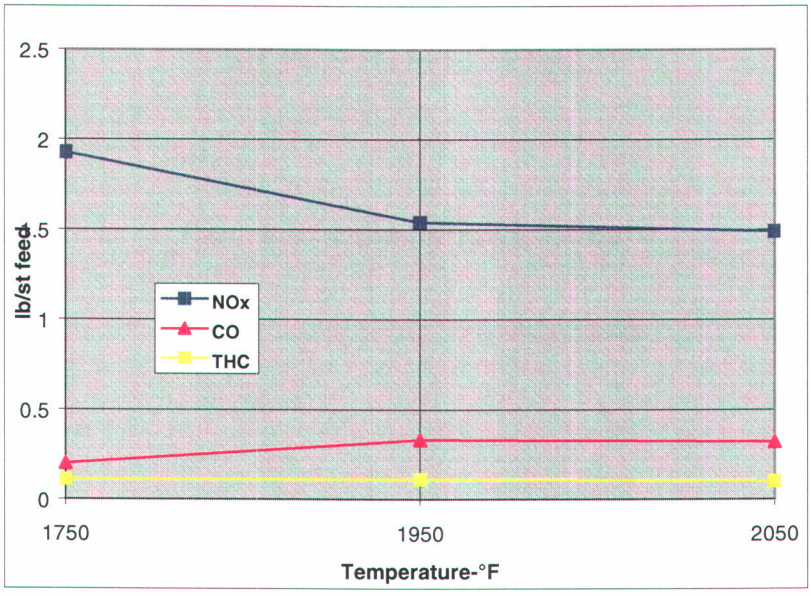


Figure 10: Emissions vs Combustion Chamber Temperture (Coal Fired)

Heat balances were performed utilizing operating data recorded for Phase 1 and Phase 6. These balances are included in Table 21 and Table 22 on Pages 58-59 in the Appendix. The Phase 1 balance (100% natural gas firing) indicates the following heat load distribution: radiation=40.9%, off gas=23.7%, trona heat of reaction=28.8%, product sensible heat=5.2%, fines sensible heat=0.9% and feed moisture=0.5%. The Phase 6 balance (100% coal firing) indicates the following heat load distribution: radiation=39.2%, off gas=27.7%, trona heat of reaction=27.1%, product sensible heat=4.4%, fines sensible heat=0.8% and feed/coal moisture=0.8%. See Table 23 on Page 60 in the Appendix for the composition of natural gas.

Process flow diagrams were generated by FFE Minerals for the following process configurations:

1. Existing #1 Calciner – Natural Gas Fired w/ 350°F Spill
2. Proposed #1 Calciner – Coal Fired
3. Existing #1 Calciner – Natural Gas Fired w/ 300°F Spill
4. Existing #1 Calciner – Natural Gas Fired w/ 250°F Spill

A comparison between configurations 1 and 2 indicate similar process gas volumes and specific fuel consumptions for natural gas and coal firing. Configurations 3 and 4 illustrate the reductions in specific fuel consumption associated with reducing the product spill temperature to 300°F (9.2%) and 250°F (15.6%). See Figure 31 - Figure 34 on Pages 61-64 in the Appendix for the process flow diagrams.

A lower spill temperature of 250°F has been proposed following the installation of a crushing circuit to reduce the feed top size from 5/16" to 4 mesh. A sample of +4 mesh trona has been shipped to a roll crusher supplier for evaluation. Further comment on configuration 4 will be provided following the completion of roll crusher and roll crusher product chemical evaluations. The chemical evaluations are being performed to determine if a post-crusher screening step would be effective at removing the shale particles which tend to flatten as opposed to breaking to minus 4 mesh in the roll crusher. This data will be provided in a supplement report.

Samples of "as received" trona feed, minus 4 mesh crushed trona feed, calciner product and filter fines were analyzed by FFE Minerals to determine moisture (feed samples only), bulk density and particle size distribution (sieve method). These results are included in Table 24 - Table 50 in the Appendix (Pages 65-91).

Prior to the conclusion of testing on 15Aug a successful attempt was made to fire the combustion chamber on coal only at 1750°F without natural gas supplementation. Flame stability and temperature control were demonstrated following a complete shutoff of the natural gas circuit.

All samples collected during this program were returned to Solvay. Bulk product, filter fines and remaining feed containers were disposed of by FFE Minerals.

CONCLUSIONS & RECOMMENDATIONS

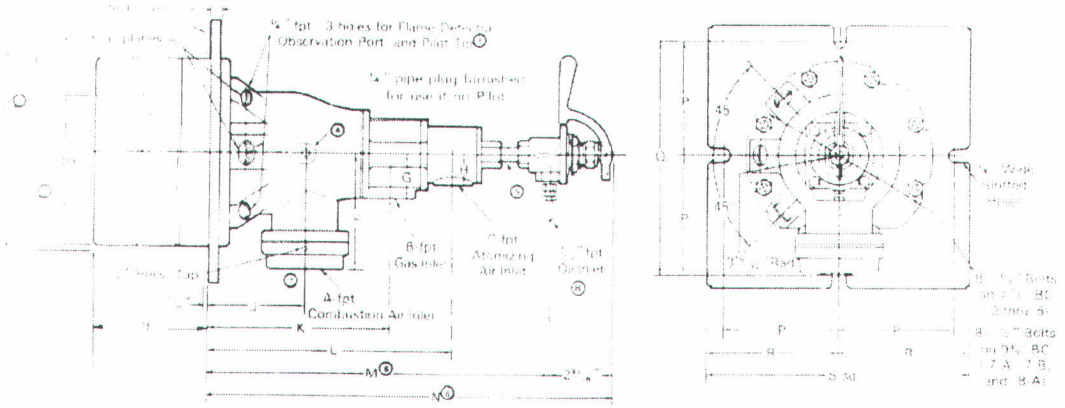
1. Stable rotary calciner operation and product bicarb levels were obtained utilizing both natural gas and coal firing in an external combustion chamber. This stability applies to combustion chamber temperatures ranging from 1750-2250°F with natural gas and 1750-2050°F with coal.
2. Product and filter fines samples representing stable operation for each of the ten test phases were sent to Solvay for further analysis. This analysis is required to determine the effect of coal firing on product quality. Therefore, no conclusion regarding product quality is provided at this time.
3. The emission of total hydrocarbons were comparable for natural gas and coal firing (0.08-0.13 lb/st trona).
4. The emission of carbon monoxide was generally higher when firing coal (0.20-0.39 lb/st trona) versus natural gas (0.12-0.21 lb/st trona).
5. The emission of NO_x increased by nearly 700% when firing 100% coal at 2050°F (1.49 lb NO_2/st trona) versus 100% natural gas firing at 2050°F (0.19 lb NO_2/st trona average). A dual zone, low NO_x burner is recommended.
6. Ash deposits representing up to 25% of the total coal ash introduced to the calciner were formed in the combustion chamber; concentrated on the tapered outlet section. The pilot results represent a worst case scenario due to the restriction at the outlet of the combustion chamber.
7. Further consideration should be given to the slagging combustion system in order to eliminate potential problems associated with ash deposition within the combustion chamber.
8. Instabilities were observed in the roller mill system during the coal grinding operation, and are attributed to the high volatile and moisture contents in the coal. Further testing is recommended to ensure proper commercial mill selection and operating parameters.

APPENDIX

North American
Mfg. Co.
Cleveland, OH 44105 USA

FIRE • ALL
DUAL-FUEL BURNERS

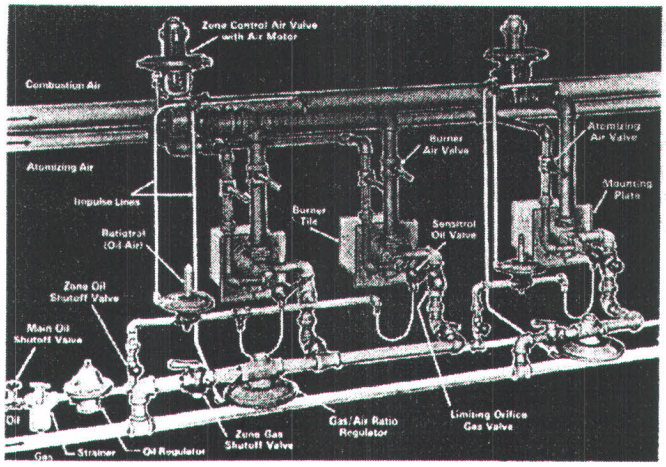
DIMENSION 6422



DIMENSIONS SHOWN ARE SUBJECT TO CHANGE. PLEASE OBTAIN CERTIFIED PRINTS FROM NORTH AMERICAN MFG. CO. IF SPACE LIMITATIONS OR OTHER CONSIDERATIONS MAKE EXACT DIMENSION(S) CRITICAL.

Burner Designation	Dimensions in inches																	
	A	B	C	D_1	$D_2$②	$D_1$③	E	F	G	H	J	K	L	M④	N④	P	Q	R	S
6422-2	1 ¼	1	¼	5	8 ½	9 ½	½	5 ¼	2	1 3/8	4 3/8	8 3/8	11 5/16	15 13/16	18 3/4	5 ¼	10 ½	6	12
6422-3	1 ½	1	¾	5	8 ½	9 ½	½	5 ¼	2	1 3/8	4 3/8	8 3/8	11 5/16	15 13/16	18 3/8	5 ¼	10 ½	6	12
6422-4	2	1 ¼	¾	5	8 ½	9 ½	½	5 ¼	2	1 3/8	4 3/8	8 3/8	11 5/16	15 13/16	18 3/8	5 ¼	10 ½	6	12
6422-5	2 ½	1 ½	1	5	8 ½	9 ½	½	5 ¼	2	1 3/8	4 3/8	8 3/8	11 5/16	15 13/16	18 3/8	5 ¼	10 ½	6	12
6422-6	3	1 ½	1	5	8 ½	9 ½	½	5 9/16	2	1 3/8	4 3/8	8 3/8	11 5/16	15 13/16	18 3/8	5 ¼	10 ½	6	12
6422-7-A	4	2 ½	1 ¼	7	10	11	9/16	6 15/16	2 3/8	2 1/8	5 3/8	11	15 1/8	20 1/16	22 5/8	6 1/8	12 ¼	6 ¾	13 ½
6422-7-B	4	2 ½	1 ¼	7	10	11	9/16	6 15/16	2 5/8	2 1/8	5 7/8	11	15 1/8	20 1/16	22 5/8	6 1/8	12 ¼	6 ¾	13 ½
6422-8-A	6	2 ½	2	7	10	11	9/16	10 11/16	2 5/8	1 ¾	5 7/8	11	15 1/8	20 1/16	22 5/8	6 1/8	12 ¼	6 ¾	13 ½

Burner Designation	Wt. lb	Sensitrol Oil Valve	Recommended Pilot Size
6422-2	83	1813-02-A	
6422-3	83	1813-02-A	4011-11
6422-4	83	1813-02-A	or
6422-5	83	1813-02-A	4011-12
6422-6	83	1813-02-B	
6422-7-A	139	1813-02-C	4011-11
6422-7-B	139	1813-02-C	or
6422-8-A	145	1813-02-C	4011-12



Piping arrangement for single-and double-burner zones.

① ¼" tpt. Flame Detector, and Observation Port positions are interchangeable as long as pilot and flame detector are in adjacent holes.
② Opening in furnace shell should be about ½" larger than dimension D_2 to allow for fillets and draft on mounting plate.
③ For 6422-1C and -1A Burners only. Opening in oven shell should be about ½" larger than dimension D_1.
④ ¼" air pressure tap on -2, -3, -4, -5, and -6.
⑤ Pipe nipple not furnished by North American.
⑥ Dimensions M and N assume the use of a ⅜" NPT close nipple between burner and Sensitrol Oil Valve.
⑦ For 6422-8-A, air and gas connections cannot be piped in the same plane because the "flower pot" type air connection flange would interfere with the 2½" gas line.
⑧ Metal tubing is offered as an extra cost option.

Figure 11: North Americal Dual Fuel Burner - Schematic

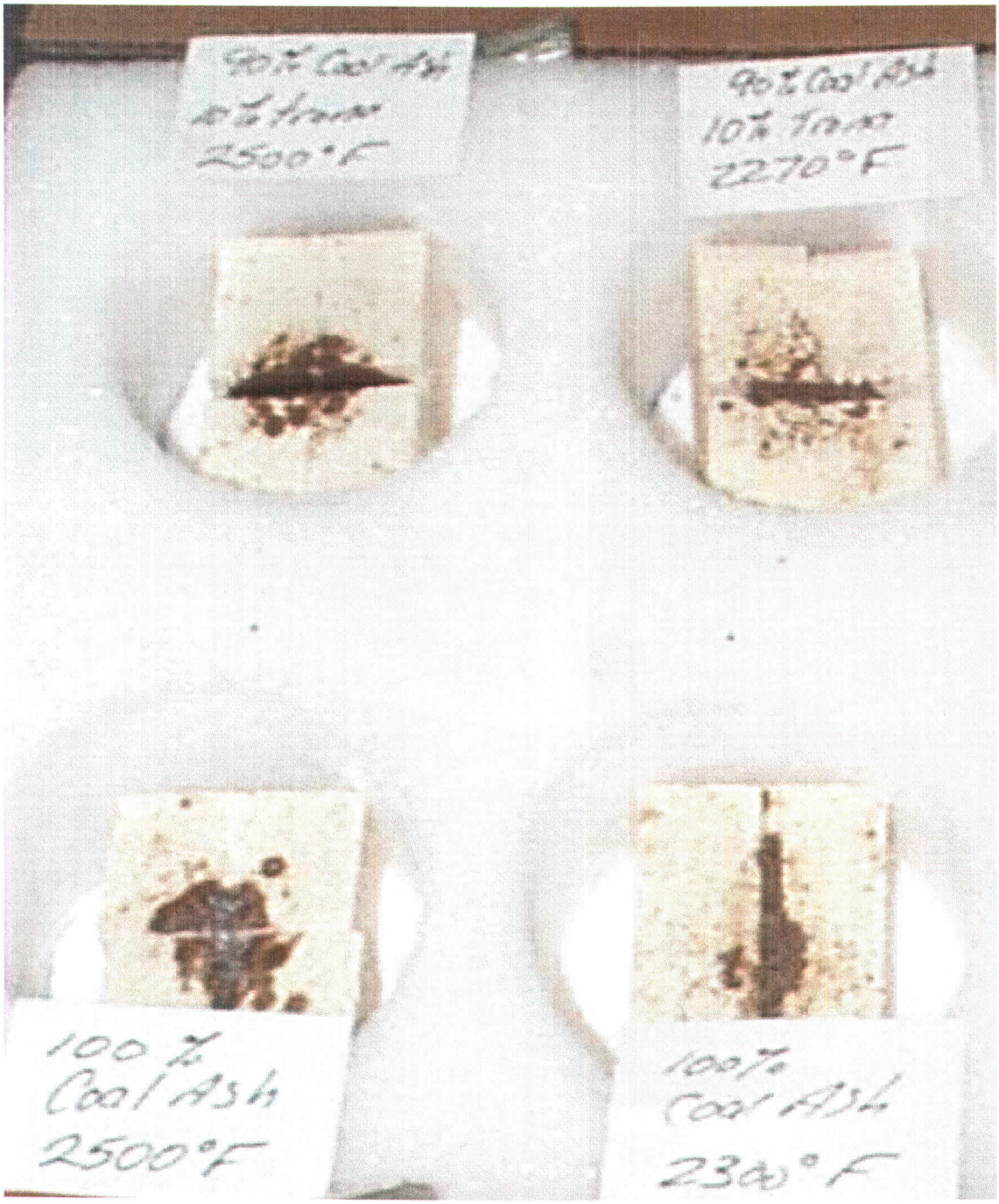


Figure 12: Laboratory Brick Samples

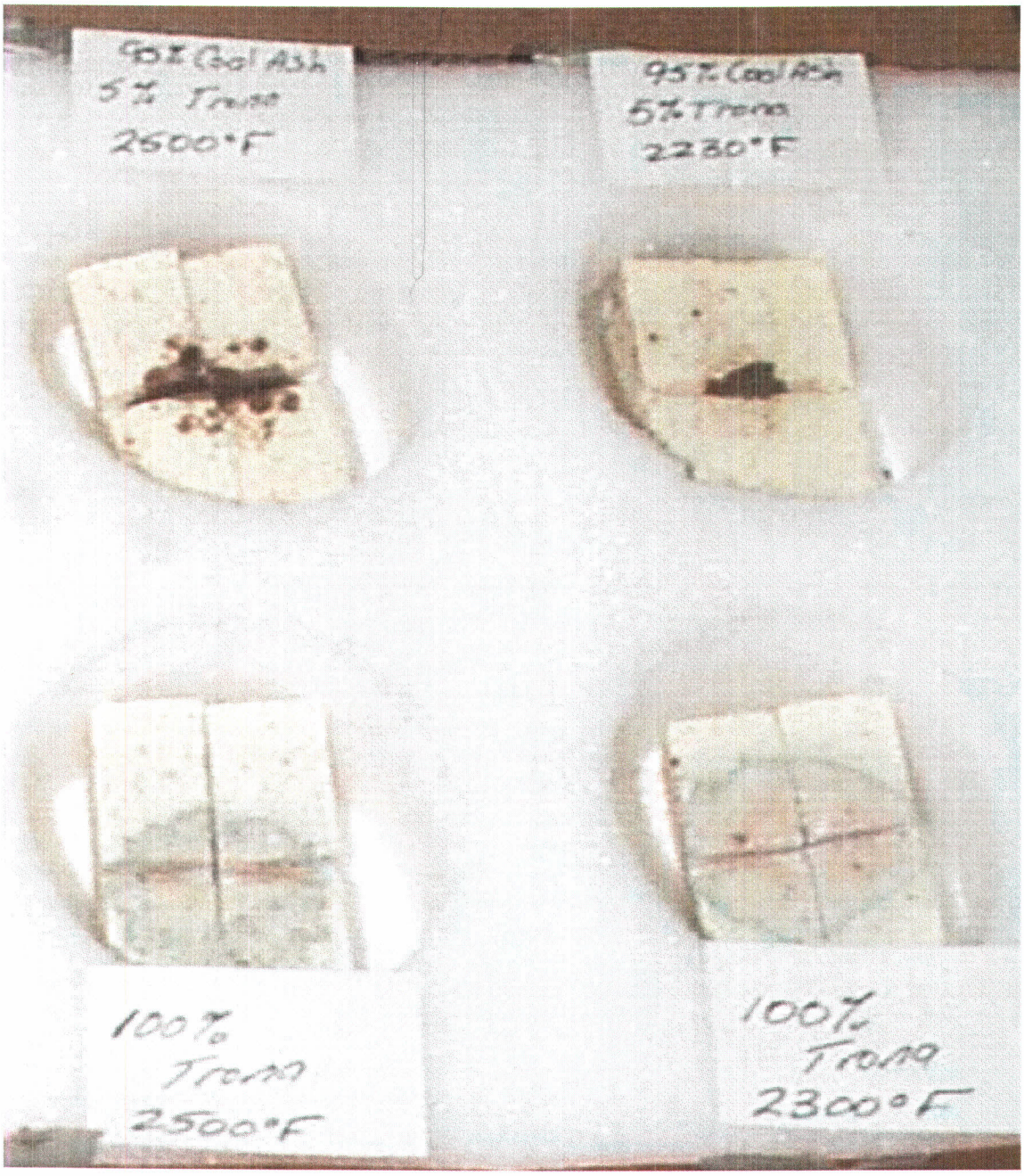
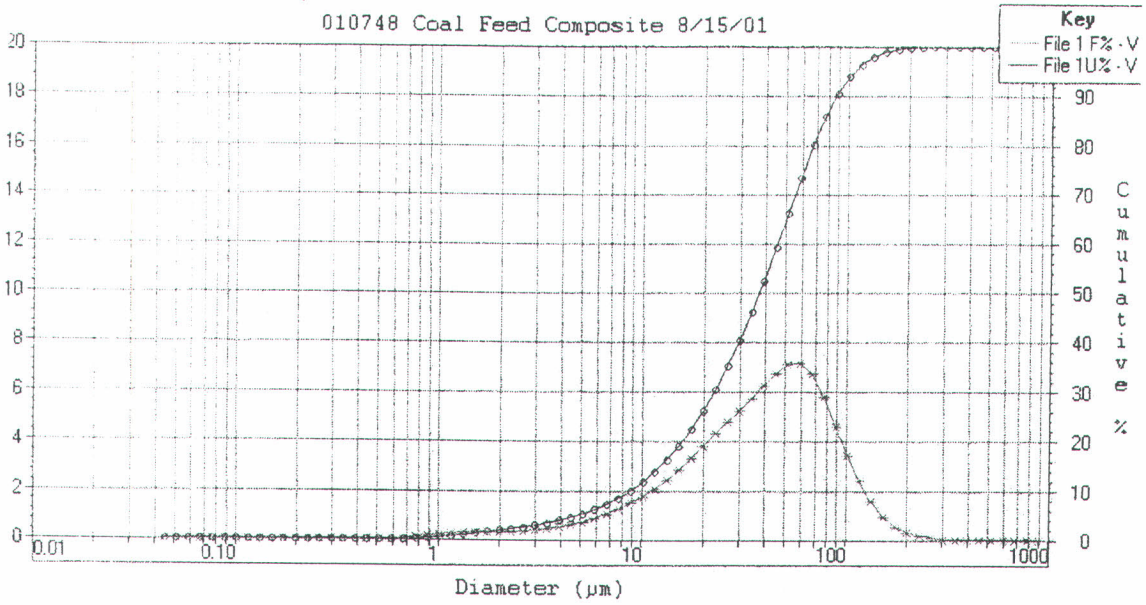


Figure 13: Laboratory Brick Samples

Table 6: Coal Combustion Analysis

Coal Ultimate Analysis:			**Free/Bound Water from Coal:**		
Ash:	7.61%		Oxygen:	0.1357	lb O/lb coal
Sulfur:	0.60%		Hydrogen:	0.0170	lb H/lb coal
Carbon:	71.53%		**Water:**	**0.1527**	**lb H2O/lb coal**
Hydrogen (incl. moisture)	5.01%			**3.2481**	**scf H2O/lb coal**
Nitrogen:	1.68%				
Oxygen (incl. moisture):	13.57%		**Combustion Products:**		
Total:	100.00%		Carbon Dioxide:	2.6227667	lb CO2/lb coal
Air Required for Combustion:				22.8305	scf CO2/lb coal
Hydrogen Available:	0.0331	lb H/lb coal	Water from H RxN:	0.2982	lb H2O/lb coal
Carbon:	0.7153	lb C/lb coal		6.3459	scf H2O/lb coal
Oxygen Required:	2.1725667	lb O2/lb coal	Total Water:	0.4509	lb H2O/lb coal
	26.003192	scf O2/lb coal		9.5940	scf H2O/lb coal
Air Required:	**123.82472**	**scf air/lb coal**	Nitrogen:	98.0513	scf N2/lb coal
			TOTAL:	**130.4758**	**scf CP/lb coal**

FL SMIDTH
Sample Name: Solvay Minerals
ID Number: 010748
File Name: Trona Calciner Test
Material: Coal Feed Composite 8/15/01 Run Date: 8/21/01



Sample	: File 1	Diameter on %		Percentage on Diameter	
Dist. Base	: Volume	10.0% :	8.821 (µm)	150.000 (µm) :	98.7%
Mean (µm)	: 44.18	20.0% :	15.774 (µm)	90.000 (µm) :	90.8%
Median (µm)	: 37.23	50.0% :	37.230 (µm)	75.000 (µm) :	84.5%
Std.Dev(µm)	: 33.67	75.0% :	60.914 (µm)	45.000 (µm) :	59.2%
Spec. Area	: 3708	90.0% :	87.357 (µm)	20.000 (µm) :	26.3%

Figure 14: Coal Laser PSD Profile

Table 7: Coal Laser PSD Data

FL SMIDTH

Sample Name: Solvay Minerals
ID Number: 010748
File Name: Trona Calciner Test
Material: Coal Feed Composite 8/15/01 Run Date: 8/21/01
Shape: 1 Ref. Index: 1.44-0.39 Laser: 80.373 Red: 84.990 Blue: 85.013
Material : Ground Coal
Source : Feed Composite 8/15/01
Proj Num : 563-00
Operator : LSD

No.	SIZE(µm)	FREQ.%	U.SIZE%	No.	SIZE(µm)	FREQ.%	U.SIZE%
(1)	1.000	0.45	0.45	(13)	53.000	8.49	67.70
(2)	2.000	1.52	1.97	(14)	75.000	16.81	84.50
(3)	3.000	1.04	3.01	(15)	90.000	6.35	90.85
(4)	4.000	1.06	4.07	(16)	106.000	3.80	94.65
(5)	5.000	1.09	5.16	(17)	150.000	4.07	98.72
(6)	6.000	1.16	6.32	(18)	212.000	1.06	99.79
(7)	10.000	5.30	11.62	(19)	300.000	0.21	100.00
(8)	15.000	7.18	18.80	(20)	425.000	0.00	100.00
(9)	20.000	7.50	26.30	(21)	600.000	0.00	100.00
(10)	25.000	7.34	33.64	(22)	850.000	0.00	100.00
(11)	32.000	9.57	43.21	(23)	1000.000	0.00	100.00
(12)	45.000	16.00	59.21				

Statistical Information		Diameter on %		Percentage on Diameter	
Dist. Base :	VOLUME	10.0% :	8.554 (µm)	150.000 (µm) :	98.7%
Mean (µm) :	44.179	20.0% :	15.706 (µm)	90.000 (µm) :	90.8%
Median (µm):	37.230	50.0% :	36.981 (µm)	75.000 (µm) :	84.5%
Std.Dev(µm):	33.673	75.0% :	61.631 (µm)	45.000 (µm) :	59.2%
Spec. Area :	3708	90.0% :	87.830 (µm)	20.000 (µm) :	26.3%

Table 8: Operating Data

DATE		13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01
PHASE										
TIME		0830	0930	1030	1130	1230	1330	1420	1530	1630
TEMPERATURE (°F):										
TC#1: COMBUSTION CHAMBER		1504	1505	1655	1745	1735	1755	1745	2056	2052
TC#2: GAS #2 (DIAL1)		760	755	630	670	620	670	670	710	680
TC#3: GAS #3 (DIAL2)		730	730	670	700	640	710	705	740	730
TC#4: GAS #4 (DIAL3)		560	540	420	450	460	470	470	520	520
TC#5: GAS #5 (DIAL4)		585	580	500	530	510	540	540	610	600
TC#6: GAS OUT		649	611	493	534	494	565	566	656	648
TC#7: MATERIAL DISCHARGE		620	477	307	309	369	339	352	343	352
TC#8: FILTER INLET		472	447	389	406	393	423	425	478	461
TC#9: FILTER EXIT		335	313	292	290	300	299	304	333	331
PRESSURE ("WG):										
PT#1: COMBUSTION CHAMBER		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
PT#2: FEED HOOD		0.08	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.05
PT#3: DISCHARGE HOOD		-0.6	-0.5	-0.9	-0.8	-0.6	-0.6	-0.6	-0.6	-0.6
PT#4: FILTER INLET - "WG		-1.3	-1.5	-2	-2.2	-1.8	-1.8	-1.9	-2	-1.8
PT#5: FILTER OUTLET - "WG		-2.5	-2.8	-3.6	-3.8	-3.7	-3.8	-3.7	-4	-3.8
GAS ANALYSIS DATA (DRY BASIS):										
COMBUSTION CHAMBER	%O2	13.40%	12.40%	10.30%	10.60%	10.60%	10.80%	11.00%	7.21%	n/a
	%COMB	0.09%	0.08%	0.09%	0.09%	0.10%	0.10%	0.10%	0.12%	n/a
	ppm CO	0	0	0	0	0	0	0	0	n/a
CALCINER OUTLET	%O2	17.20%	16.00%	15.80%	15.60%	16.40%	15.70%	15.70%	12.30%	13.20%
	%COMB	0.09%	0.08%	0.08%	0.09%	0.09%	0.10%	0.10%	0.13%	0.15%
	ppm CO	1	0	0	2	1	2	1	12	11
FILTER OUTLET	ppm SO2	0	0	n/a	5	4	4	4	4	3
	ppm NOx	14	14	n/a	7	6	9	9	19	20
	ppm CO	42	30	n/a	19	11	21	13	40	34
	%CO2	4.56%	4.36%	n/a	2.09%	1.79%	2.02%	2.05%	2.87%	2.97%
	%O2	15.20%	15.50%	n/a	18.00%	18.40%	18.10%	18.10%	17.00%	17.10%
	ppm THC	n/a	n/a	n/a	9	6	8	7	14	12
	ppm CH4	n/a	n/a	n/a	5	3	3	3	6	4
AIR HEATER OUTLET:										
MAIN AIR (SCFM):		181.3	181.0	153.3	173.2	146.7	172.9	174.4	174.0	173.7
STATIC PRESS-"Hg		2.1	2.1	1.6	1.8	1.35	1.8	1.85	1.85	1.85
DIFFER. PRESS-"WG		0.56	0.56	0.41	0.52	0.38	0.52	0.53	0.53	0.53
AIR TEMP.- C		29.7	30.8	31.9	32	33	33	34	35.5	36.5
ATOMIZING AIR (SCFM):		11.5	11.5	11.6	11.6	11.6	11.6	11.6	11.6	11.6
METER READING--CFM		6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
OUTPUT PRESS-psig		31	31	32	32	32	32	32	32	32
k FACTOR		1	1	1	1	1	1	1	1	1
EDUCTOR AIR (SCFM):		6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
METER READING--CFM		5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
OUTPUT PRESS-psig		3	3	3	3	3	3	3	3	3
k FACTOR		0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979
SUCTION FLOW - SCFM		1	1	1	1	1	1	1	1	1
OXYGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
NITROGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
SULFUR DIOXIDE (SCFM):		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 9: Operating Data

DATE	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01
PHASE									
TIME	0830	0930	1030	1130	1230	1330	1420	1530	1630
METER READING--CFH	0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
SO2 INJECTION (LB/HR):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LB SO2/LB TRONA FEED:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WATER (SCFM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--GPH	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
TOTAL INPUT (SCFM):	199.5	199.2	171.7	191.6	165.1	191.3	192.8	192.4	192.1
TRONA FEED (LB/HR):	400.0	750.0	750.0	650.0	625.0	625.0	625.0	895.0	895.0
TRONA FEED (STPH):	0.2	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4
NATURAL GAS (SCFM):	8.1	8.1	8.6	9.1	6.6	8.1	8.1	11.1	10.9
METER READING--CFM	5.5	5.5	6	6.2	4	5.5	5.5	7	6.7
OUTPUT PRESS-psig	4	4	3	4	9	4	4	7	8
k FACTOR	1	1	1	1	1	1	1	1	1
NATURAL GAS (BTU/HR LHV):	448,497	448,497	476,007	505,578	367,206	448,497	448,497	614,899	601,954
COAL (LB/HR):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL (BTU/HR LHV):	0	0	0	0	0	0	0	0	0
COAL RATE (MMBtu/st FEED):	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
% OF MAXIMUM COAL RATE:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL FUEL INPUT (BTU/HR LHV):	448,497	448,497	476,007	505,578	367,206	448,497	448,497	614,899	601,954
TOTAL FUEL INPUT (MMBTU/st FEED):	2.24	1.20	1.27	1.56	1.18	1.44	1.44	1.37	1.35
%NATURAL GAS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
%COAL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ADJUSTED INPUT (SCFM):	207.8	207.5	180.5	200.9	171.9	199.5	201.1	203.7	203.2
ADJUSTED INPUT (ACFM):	770.0	769.1	720.1	835.7	711.8	833.9	836.4	966.9	962.9
INLET VELOCITY (FPS):	7.3	7.3	6.8	7.9	6.7	7.9	7.9	9.1	9.1
INLET VELOCITY (MPS):	2.2	2.2	2.1	2.4	2.0	2.4	2.4	2.8	2.8
FLOW COMPOSITION:									
NITROGEN (SCFM)	157.6	157.4	135.7	151.4	130.5	151.1	152.3	152.0	151.8
OXYGEN (SCFM)	25.4	25.3	18.5	21.6	21.2	23.7	24.0	17.8	18.2
CARBON DIOXIDE (SCFM)	8.4	8.4	8.9	9.5	6.9	8.4	8.4	11.6	11.3
WATER (SCFM)	16.3	16.3	17.3	18.4	13.4	16.3	16.3	22.4	21.9
DRY FLOW (DSCFM):	191.5	191.1	163.1	182.5	158.5	183.2	184.7	181.3	181.3
%NITROGEN	75.87%	75.86%	75.17%	75.35%	75.90%	75.74%	75.76%	74.62%	74.70%
%OXYGEN	12.23%	12.21%	10.28%	10.77%	12.31%	11.86%	11.93%	8.73%	8.95%
%OXYGEN (DRY)	13.27%	13.25%	11.37%	11.85%	13.35%	12.92%	12.98%	9.80%	10.04%
%CARBON DIOXIDE	4.06%	4.06%	4.96%	4.73%	4.02%	4.22%	4.19%	5.67%	5.57%
%WATER	7.85%	7.86%	9.59%	9.15%	7.77%	8.17%	8.11%	10.98%	10.77%
CALCINER EXIT:									
COMBUSTION PRODUCTS (SCFM):*	121.1	151.0	156.4	153.5	124.6	140.3	140.3	195.7	193.2
COMBUSTION PRODUCTS (DSCFM):	76.3	81.2	85.6	88.8	66.7	79.5	79.5	109.5	107.4
REQUIRED AIR (SCFM):	78.6	78.6	83.4	88.6	64.3	78.6	78.6	107.7	105.5
EXCESS AIR (SCFM):	345.1	260.0	260.0	256.5	237.7	235.4	235.4	154.8	181.8
TOTAL FLOW (SCFM):	466.2	411.0	416.3	410.0	362.3	375.7	375.7	350.4	375.0
TOTAL FLOW (ACFM):	975.6	830.5	748.6	769.0	652.1	726.6	727.3	737.9	783.9
FLOW COMPOSITION:									
NITROGEN (SCFM)	334.7	267.4	271.3	272.6	238.6	248.0	248.0	207.4	227.0
OXYGEN (SCFM)	72.5	54.6	54.6	53.9	49.9	49.4	49.4	32.5	38.2
CARBON DIOXIDE (SCFM)	14.1	19.1	19.6	18.8	15.8	17.3	17.3	24.3	24.1
WATER (SCFM)	44.8	69.8	70.8	64.7	57.9	60.9	60.9	86.1	85.7
EXIT VELOCITY (FPS):	9.2	7.8	7.1	7.3	6.2	6.9	6.9	7.0	7.4
EXIT VELOCITY (MPS):	2.8	2.4	2.2	2.2	1.9	2.1	2.1	2.1	2.3

Table 10: Operating Data

DATE	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01	13-Aug-01
PHASE									
TIME	0830	0930	1030	1130	1230	1330	1420	1530	1630
%NITROGEN	71.81%	65.09%	65.17%	66.50%	65.87%	66.03%	66.03%	59.20%	60.54%
%OXYGEN	15.55%	13.29%	13.12%	13.14%	13.78%	13.16%	13.16%	9.28%	10.19%
%OXYGEN (DRY)	17.20%	16.00%	15.80%	15.60%	16.40%	15.70%	15.70%	12.30%	13.20%
%CARBON DIOXIDE	3.03%	4.65%	4.72%	4.58%	4.36%	4.61%	4.61%	6.94%	6.42%
%WATER	9.61%	16.98%	17.00%	15.78%	15.98%	16.20%	16.20%	24.59%	22.85%
CALCINER SPEED - RPM	3.5	3.5	3.5	3.2	3.2	3.2	3.2	3.2	3.2
MATERIAL RESIDENCE TIME (min):	15.0	15.0	15.0	16.7	22.3	16.7	16.7	16.7	16.7
EMISSIONS:									
FILTER EXIT FLOW (SCFM):	242.5	249.6	292.9	299.4	294.4	291.5	290.5	316.8	291.5
STATIC PRESS-"WG	-3.4	-3.4	-4.3	-4.5	-4.5	-4.5	-4.5	-4.5	-4.5
DIFFER. PRESS-"WG	0.34	0.35	0.47	0.49	0.48	0.47	0.47	0.58	0.49
AIR TEMP.-°F	335	313	292	290	300	299	304	333	331
FILTER EXIT FLOW (DSCFM):	197.7	179.8	222.1	234.7	236.5	230.6	229.7	230.6	205.8
SO2 (LB/HR):	0.0000	0.0000	n/a	0.0117	0.0094	0.0092	0.0091	0.0092	0.0061
SO2 (LB/ST TRONA):	0.0000	0.0000	n/a	0.0359	0.0301	0.0293	0.0292	0.0205	0.0137
NOx (LB/HR as NO2):	0.0198	0.0180	n/a	0.0117	0.0101	0.0148	0.0148	0.0313	0.0294
NOx (LB/ST TRONA):	0.0988	0.0479	n/a	0.0361	0.0324	0.0474	0.0472	0.0699	0.0657
CO (LB/HR):	0.0361	0.0234	n/a	0.0194	0.0113	0.0210	0.0130	0.0401	0.0304
CO (LB/ST TRONA):	0.1804	0.0625	n/a	0.0596	0.0362	0.0673	0.0415	0.0896	0.0680
THC (LB/HR as C3H8):	n/a	n/a	n/a	0.0144	0.0097	0.0126	0.0110	0.0220	0.0169
THC (LB/ST TRONA):	n/a	n/a	n/a	0.0444	0.0310	0.0403	0.0351	0.0493	0.0377
CH4 (LB/HR):	n/a	n/a	n/a	0.0029	0.0019	0.0017	0.0017	0.0034	0.0020
CH4 (LB/ST TRONA):	n/a	n/a	n/a	0.0091	0.0060	0.0055	0.0055	0.0077	0.0046
MISC. DATA:									
OFF GAS DAMPER POSITION (%):	7%	7%	9%	9%	9%	9%	9%	9%	9%

Table 11: Operating Data

DATE		13-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01
PHASE						1	1	1	2	2
TIME		1730	1330	1400	1500	1600	1700	1800	1845	1930
TEMPERATURE (°F):										
TC#1: COMBUSTION CHAMBER		2052	2042	2056	2074	2070	2096	2095	2249	2270
TC#2: GAS #2 (DIAL1)		580	570	605	750	720	715	740	760	695
TC#3: GAS #3 (DIAL2)		580	620	640	695	660	660	700	700	700
TC#4: GAS #4 (DIAL3)		350	390	395	480	425	450	450	440	460
TC#5: GAS #5 (DIAL4)		420	440	440	525	480	500	490	500	520
TC#6: GAS OUT		384	492	490	547	500	516	505	509	521
TC#7: MATERIAL DISCHARGE		359	350	335	423	404	414	401	410	408
TC#8: FILTER INLET		315	332	329	359	346	350	344	356	359
TC#9: FILTER EXIT		265	225	220	225	237	238	238	244	244
PRESSURE ("WG):										
PT#1: COMBUSTION CHAMBER		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PT#2: FEED HOOD		0.02	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
PT#3: DISCHARGE HOOD		-1.1	-0.1	-0.1	-0.1	-0.1	0	0	-0.1	-0.2
PT#4: FILTER INLET - "WG		-2	-0.4	-0.4	-0.4	-0.6	-0.6	-0.6	-0.6	-0.6
PT#5: FILTER OUTLET - "WG		-3.6	-1	-1	-1	-1.5	-1.6	-1.6	-1.6	-1.6
GAS ANALYSIS DATA (DRY BASIS):										
COMBUSTION CHAMBER	%O2	6.71%	5.02%	5.22%	5.47%	5.72%	5.38%	5.55%	3.38%	3.22%
	%COMB	0.14%	0.11%	0.11%	0.10%	0.10%	0.11%	0.11%	0.11%	0.11%
	ppm CO	0	85	67	52	5	42	40	47	48
CALCINER OUTLET	%O2	15.00%	10.00%	9.97%	10.30%	13.00%	12.80%	13.00%	11.90%	11.50%
	%COMB	0.00%	0.13%	0.12%	0.12%	0.11%	0.11%	0.11%	0.11%	0.11%
	ppm CO	0	243	186	226	134	129	98	125	124
FILTER OUTLET	ppm SO2	3	3	4	4	3	3	3	3	3
	ppm NOx	13	25	24	26	19	20	20	29	28
	ppm CO	9	66	70	78	36	40	26	36	43
	%CO2	2.76%	7.16%	7.14%	6.72%	5.12%	4.95%	4.95%	5.96%	5.88%
	%O2	17.10%	11.90%	12.10%	12.40%	14.70%	14.70%	14.70%	13.60%	13.60%
	ppm THC	6	21	21	21	17	16	12	14	15
	ppm CH4	2	6	6	6	5	5	3	4	4
AIR HEATER OUTLET:										
MAIN AIR (SCFM):		84.5	90.0	90.0	89.7	89.7	89.6	85.8	85.6	85.7
STATIC PRESS-"Hg		0.6	7	7	7	7	7	7	7	7.1
DIFFER. PRESS-"WG		0.13	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11
AIR TEMP.-°C		35	31	31	33	33	34	34	35	35
ATOMIZING AIR (SCFM):		11.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
METER READING--CFM		6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
OUTPUT PRESS-psig		32	40	40	40	40	40	40	40	40
k FACTOR		1	1	1	1	1	1	1	1	1
EDUCTOR AIR (SCFM):		6.8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
METER READING--CFM		5.4	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
OUTPUT PRESS-psig		3	3	3	3	3	3	3	3	3
k FACTOR		0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979
SUCTION FLOW - SCFM		1	1	1	1	1	1	1	1	1
OXYGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
NITROGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
SULFUR DIOXIDE (SCFM):		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 12: Operating Data

DATE	13-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01
PHASE					1	1	1	2	2
TIME	1730	1330	1400	1500	1600	1700	1800	1845	1930
METER READING--CFH	0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
SO2 INJECTION (LB/HR):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LB SO2/LB TRONA FEED:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WATER (SCFM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--GPH	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
TOTAL INPUT (SCFM):	102.9	109.6	109.6	109.3	109.3	109.1	105.3	105.2	105.3
TRONA FEED (LB/HR):	615.0	495.0	475.0	345.0	345.0	345.0	345.0	470.0	450.0
TRONA FEED (STPH):	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
NATURAL GAS (SCFM):	5.5	6.7	6.7	6.7	6.7	6.7	6.7	6.9	6.9
METER READING--CFM	3	4	4	4	4	4	4	4.2	4.2
OUTPUT PRESS-psig	14	9.5	9.5	9.5	9.5	9.5	9.5	8.5	8.5
k FACTOR	1	1	1	1	1	1	1	1	1
NATURAL GAS (BTU/HR LHV):	303,067	371,060	371,060	371,060	371,060	371,060	371,060	381,478	381,478
COAL (LB/HR):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL (BTU/HR LHV):	0	0	0	0	0	0	0	0	0
COAL RATE (MMBtu/st FEED):	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
% OF MAXIMUM COAL RATE:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL FUEL INPUT (BTU/HR LHV):	303,067	371,060	371,060	371,060	371,060	371,060	371,060	381,478	381,478
TOTAL FUEL INPUT (MMBTU/st FEED):	0.99	1.50	1.56	2.15	2.15	2.15	2.15	1.62	1.70
%NATURAL GAS	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
%COAL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
ADJUSTED INPUT (SCFM):	108.5	116.4	116.4	116.1	116.1	115.9	112.1	112.2	112.3
ADJUSTED INPUT (ACFM):	514.0	549.4	552.5	555.0	554.2	559.2	540.6	573.4	578.5
INLET VELOCITY (FPS):	4.8	5.2	5.2	5.2	5.2	5.3	5.1	5.4	5.5
INLET VELOCITY (MPS):	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7
FLOW COMPOSITION:									
NITROGEN (SCFM)	81.3	86.6	86.6	86.3	86.3	86.2	83.2	83.1	83.2
OXYGEN (SCFM)	10.5	9.4	9.4	9.3	9.3	9.3	8.5	8.1	8.1
CARBON DIOXIDE (SCFM)	5.7	7.0	7.0	7.0	7.0	7.0	7.0	7.2	7.2
WATER (SCFM)	11.0	13.5	13.5	13.5	13.5	13.5	13.5	13.9	13.9
DRY FLOW (DSCFM):	97.4	102.9	102.9	102.6	102.6	102.5	98.6	98.3	98.4
%NITROGEN	74.95%	74.38%	74.38%	74.36%	74.36%	74.36%	74.20%	74.07%	74.07%
%OXYGEN	9.64%	8.04%	8.04%	8.01%	8.01%	7.99%	7.55%	7.18%	7.19%
%OXYGEN (DRY)	10.73%	9.09%	9.09%	9.06%	9.06%	9.04%	8.58%	8.19%	8.20%
%CARBON DIOXIDE	5.25%	5.99%	5.99%	6.01%	6.01%	6.02%	6.22%	6.39%	6.38%
%WATER	10.16%	11.59%	11.59%	11.62%	11.62%	11.64%	12.03%	12.37%	12.35%
CALCINER EXIT:									
COMBUSTION PRODUCTS (SCFM):*	111.3	114.2	112.5	101.4	101.4	101.4	101.4	114.1	112.4
COMBUSTION PRODUCTS (DSCFM):	56.4	65.4	65.1	63.3	63.3	63.3	63.3	66.7	66.4
REQUIRED AIR (SCFM):	53.1	65.0	65.0	65.0	65.0	65.0	65.0	66.8	66.8
EXCESS AIR (SCFM):	141.1	59.5	58.9	60.9	102.8	98.8	102.8	87.2	80.4
TOTAL FLOW (SCFM):	252.4	173.7	171.4	162.3	204.2	200.2	204.2	201.3	192.8
TOTAL FLOW (ACFM):	401.9	312.0	307.2	308.4	369.9	368.6	371.8	368.1	356.8
FLOW COMPOSITION:									
NITROGEN (SCFM)	153.4	98.3	97.9	99.5	132.6	129.4	132.6	121.7	116.3
OXYGEN (SCFM)	29.6	12.5	12.4	12.8	21.6	20.7	21.6	18.3	16.9
CARBON DIOXIDE (SCFM)	14.5	14.0	13.7	11.9	11.9	11.9	11.9	13.9	13.6
WATER (SCFM)	54.9	48.8	47.3	38.1	38.1	38.1	38.1	47.4	45.9
EXIT VELOCITY (FPS):	3.8	2.9	2.9	2.9	3.5	3.5	3.5	3.5	3.4
EXIT VELOCITY (MPS):	1.2	0.9	0.9	0.9	1.1	1.1	1.1	1.1	1.0

Table 13: Operating Data

DATE	13-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01	14-Aug-01
PHASE					1	1	1	2	2
TIME	1730	1330	1400	1500	1600	1700	1800	1845	1930
%NITROGEN	60.79%	56.64%	57.13%	61.32%	64.95%	64.66%	64.95%	60.47%	60.35%
%OXYGEN	11.74%	7.19%	7.22%	7.88%	10.58%	10.37%	10.58%	9.10%	8.76%
%OXYGEN (DRY)	15.00%	10.00%	9.97%	10.30%	13.00%	12.80%	13.00%	11.90%	11.50%
%CARBON DIOXIDE	5.73%	8.08%	8.02%	7.33%	5.82%	5.94%	5.82%	6.89%	7.05%
%WATER	21.74%	28.09%	27.63%	23.47%	18.65%	19.03%	18.65%	23.54%	23.84%
CALCINER SPEED - RPM	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
MATERIAL RESIDENCE TIME (min):	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
EMISSIONS:									
FILTER EXIT FLOW (SCFM):	304.5	250.2	251.1	250.2	247.8	247.7	247.7	246.6	246.6
STATIC PRESS-"WG	-4.4	-1.1	-1.1	-1.1	-1.8	-1.8	-1.8	-1.8	-1.8
DIFFER. PRESS-"WG	0.49	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
AIR TEMP.-°F	265	225	220	225	237	238	238	244	244
FILTER EXIT FLOW (DSCFM):	249.7	201.4	203.8	212.1	209.8	209.6	209.6	199.2	200.7
SO2 (LB/HR):	0.0074	0.0068	0.0071	0.0074	0.0067	0.0067	0.0060	0.0056	0.0055
SO2 (LB/ST TRONA):	0.0242	0.0274	0.0298	0.0428	0.0386	0.0386	0.0345	0.0237	0.0243
NOx (LB/HR as NO2):	0.0232	0.0354	0.0351	0.0386	0.0283	0.0295	0.0302	0.0412	0.0395
NOx (LB/ST TRONA):	0.0754	0.1429	0.1480	0.2241	0.1641	0.1712	0.1753	0.1753	0.1756
CO (LB/HR):	0.0098	0.0578	0.0619	0.0714	0.0324	0.0360	0.0239	0.0310	0.0379
CO (LB/ST TRONA):	0.0318	0.2337	0.2606	0.4142	0.1880	0.2085	0.1384	0.1320	0.1685
THC (LB/HR as C3H8):	0.0102	0.0289	0.0294	0.0307	0.0241	0.0233	0.0176	0.0186	0.0201
THC (LB/ST TRONA):	0.0333	0.1167	0.1236	0.1780	0.1395	0.1352	0.1020	0.0793	0.0895
CH4 (LB/HR):	0.0012	0.0030	0.0031	0.0031	0.0025	0.0024	0.0018	0.0020	0.0018
CH4 (LB/ST TRONA):	0.0040	0.0121	0.0128	0.0180	0.0146	0.0141	0.0103	0.0087	0.0078
MISC. DATA:									
OFF GAS DAMPER POSITION (%):	9%	5%	5%	5%	6%	6%	6%	6%	6%

Table 14: Operating Data

DATE		15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01
PHASE		3	3	3	4	5	5	6	6	6
TIME		0830	0930	1030	1130	1230	1330	1430	1530	1630
TEMPERATURE (°F):										
TC#1: COMBUSTION CHAMBER		2046	2047	2059	2056	2050	2062	2058	2053	2062
TC#2: GAS #2 (DIAL1)		790	730	725	730	740	750	750	740	730
TC#3: GAS #3 (DIAL2)		720	680	680	680	675	680	685	680	660
TC#4: GAS #4 (DIAL3)		510	470	460	455	460	450	460	445	450
TC#5: GAS #5 (DIAL4)		560	530	515	520	520	510	515	505	510
TC#6: GAS OUT		556	542	525	526	530	524	527	521	526
TC#7: MATERIAL DISCHARGE		427	420	397	401	413	401	400	402	406
TC#8: FILTER INLET		376	366	357	358	361	356	357	356	357
TC#9: FILTER EXIT		237	242	241	241	243	241	241	241	240
PRESSURE ("WG):										
PT#1: COMBUSTION CHAMBER		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PT#2: FEED HOOD		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
PT#3: DISCHARGE HOOD		-0.2	-0.2	-0.15	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
PT#4: FILTER INLET - "WG		-0.7	-0.7	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6	-0.6
PT#5: FILTER OUTLET - "WG		-1.7	-1.7	-1.6	-1.7	-1.6	-1.6	-1.6	-1.6	-1.5
GAS ANALYSIS DATA (DRY BASIS):										
COMBUSTION CHAMBER	%O2	3.40%	4.58%	4.72%	4.52%	4.88%	4.70%	4.95%	4.86%	4.44%
	%COMB	0.10%	0.09%	0.09%	0.09%	0.09%	0.09%	0.10%	0.13%	0.71%
	ppm CO	235	85	100	192	298	375	577	348	673
CALCINER OUTLET	%O2	12.30%	12.70%	12.40%	12.10%	12.20%	12.10%	12.10%	12.00%	11.80%
	%COMB	0.09%	0.09%	0.10%	0.10%	0.09%	0.09%	0.09%	0.10%	0.10%
	ppm CO	221	179	209	237	277	303	377	477	515
FILTER OUTLET	ppm SO2	0	0	0	0	0	0	0	0	0
	ppm NOx	63	74	92	144	176	167	187	185	182
	ppm CO	66	59	64	79	64	58	62	85	379
	%CO2	5.63%	5.46%	5.65%	5.98%	6.07%	6.13%	6.47%	6.32%	6.71%
	%O2	13.80%	14.20%	14.20%	14.10%	14.30%	14.30%	14.20%	14.50%	14.00%
	ppm THC	13	13	15	14	13	13	13	13	13
	ppm CH4	3	2	3	2	2	2	2	3	4
AIR HEATER OUTLET:										
MAIN AIR (SCFM):		83.6	83.7	83.6	80.1	87.0	87.0	86.7	86.6	86.5
STATIC PRESS-"Hg		1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
DIFFER. PRESS-"WG		0.12	0.12	0.12	0.11	0.13	0.13	0.13	0.13	0.13
AIR TEMP.-°C		29	29	30	30	30	30	32	33	34
ATOMIZING AIR (SCFM):		11.0	11.0	11.0	11.0	11.2	11.2	11.2	11.2	11.2
METER READING--CFM		6	6	6	6	6.2	6.2	6.2	6.2	6.2
OUTPUT PRESS-psig		35	35	35	35	33	33	33	33	33
k FACTOR		1	1	1	1	1	1	1	1	1
EDUCTOR AIR (SCFM):		7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
METER READING--CFM		5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
OUTPUT PRESS-psig		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
k FACTOR		0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979
SUCTION FLOW - SCFM		1	1	1	1	1	1	1	1	1
OXYGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
NITROGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0	0
SULFUR DIOXIDE (SCFM):		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 15: Operating Data

DATE	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01
PHASE	3	3	3	4	5	5	6	6	6
TIME	0830	0930	1030	1130	1230	1330	1430	1530	1630
METER READING--CFH	0	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
SO2 INJECTION (LB/HR):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LB SO2/LB TRONA FEED:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WATER (SCFM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--GPH	0	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0	0
TOTAL INPUT (SCFM):	101.7	101.9	101.7	98.2	105.3	105.3	105.0	104.9	104.7
TRONA FEED (LB/HR):	410.0	435.0	390.0	373.0	373.0	373.0	373.0	373.0	373.0
TRONA FEED (STPH):	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
NATURAL GAS (SCFM):	5.9	5.5	5.3	4.7	4.0	4.0	3.6	3.4	3.4
METER READING--CFM	3.5	3.2	3.1	2.7	2.3	2.3	1.92	1.8	1.83
OUTPUT PRESS-psig	10	10.5	10.5	12	12	12	16	16	16
k FACTOR	1	1	1	1	1	1	1	1	1
NATURAL GAS (BTU/HR LHV):	328,014	302,919	293,453	263,085	224,109	224,109	200,607	188,069	191,204
COAL (LB/HR):	6.0	6.4	5.7	10.9	16.4	16.4	21.9	21.9	21.9
COAL (BTU/HR LHV):	71,712	75,895	68,126	130,276	196,012	196,012	261,747	261,747	261,747
COAL RATE (MMBtu/st FEED):	0.350	0.349	0.349	0.699	1.051	1.051	1.403	1.403	1.403
% OF MAXIMUM COAL RATE:	24.99%	24.92%	24.95%	49.90%	75.07%	75.07%	100.25%	100.25%	100.25%
TOTAL FUEL INPUT (BTU/HR LHV):	399,726	378,814	361,579	393,361	420,121	420,121	462,354	449,817	452,951
TOTAL FUEL INPUT (MMBTU/st FEED):	1.95	1.74	1.85	2.11	2.25	2.25	2.48	2.41	2.43
%NATURAL GAS	82.06%	79.97%	81.16%	66.88%	53.34%	53.34%	43.39%	41.81%	42.21%
%COAL	17.94%	20.03%	18.84%	33.12%	46.66%	46.66%	56.61%	58.19%	57.79%
ADJUSTED INPUT (SCFM):	108.4	108.1	107.8	104.2	111.2	111.2	111.1	110.8	110.7
ADJUSTED INPUT (ACFM):	512.7	511.6	512.2	494.8	526.8	529.3	527.9	525.1	526.6
INLET VELOCITY (FPS):	4.8	4.8	4.8	4.7	5.0	5.0	5.0	5.0	5.0
INLET VELOCITY (MPS):	1.5	1.5	1.5	1.4	1.5	1.5	1.5	1.5	1.5
FLOW COMPOSITION:									
NITROGEN (SCFM)	80.4	80.5	80.4	77.6	83.2	83.2	83.0	82.8	82.7
OXYGEN (SCFM)	6.7	7.5	8.1	6.2	6.8	6.8	5.2	5.6	5.5
CARBON DIOXIDE (SCFM)	8.4	8.1	7.7	9.1	10.5	10.5	12.1	11.9	11.9
WATER (SCFM)	12.9	12.0	11.6	11.3	10.8	10.8	10.8	10.3	10.5
DRY FLOW (DSCFM):	95.5	96.1	96.2	92.9	100.4	100.4	100.2	100.3	100.1
%NITROGEN	74.13%	74.42%	74.59%	74.42%	74.78%	74.78%	74.65%	74.80%	74.76%
%OXYGEN	6.18%	6.93%	7.51%	5.96%	6.08%	6.08%	4.66%	5.07%	4.94%
%OXYGEN (DRY)	7.01%	7.80%	8.42%	6.69%	6.73%	6.73%	5.17%	5.59%	5.46%
%CARBON DIOXIDE	7.79%	7.50%	7.13%	8.72%	9.40%	9.40%	10.89%	10.72%	10.78%
%WATER	11.88%	11.12%	10.75%	10.85%	9.68%	9.68%	9.71%	9.34%	9.45%
CALCINER EXIT:									
COMBUSTION PRODUCTS (SCFM):*	111.7	109.7	102.6	106.6	111.0	111.0	118.4	116.0	116.6
COMBUSTION PRODUCTS (DSCFM):	69.5	66.6	63.2	68.7	73.6	73.6	81.0	79.0	79.5
REQUIRED AIR (SCFM):	69.9	66.2	63.2	68.6	73.1	73.1	80.3	78.1	78.7
EXCESS AIR (SCFM):	98.3	102.0	91.1	93.3	102.0	100.1	110.1	105.4	102.0
TOTAL FLOW (SCFM):	210.0	211.7	193.7	199.9	213.0	211.1	228.5	221.3	218.5
TOTAL FLOW (ACFM):	402.5	400.2	360.0	371.9	397.9	391.8	425.5	409.6	406.6
FLOW COMPOSITION:									
NITROGEN (SCFM)	132.8	132.8	121.9	127.9	138.4	136.8	150.5	145.0	142.7
OXYGEN (SCFM)	20.6	21.4	19.1	19.6	21.4	21.0	23.1	22.1	21.4
CARBON DIOXIDE (SCFM)	14.3	14.3	13.2	14.4	15.8	15.8	17.4	17.2	17.2
WATER (SCFM)	42.1	43.0	39.4	37.9	37.4	37.4	37.4	36.9	37.0
EXIT VELOCITY (FPS):	3.8	3.8	3.4	3.5	3.8	3.7	4.0	3.9	3.8
EXIT VELOCITY (MPS):	1.2	1.2	1.0	1.1	1.1	1.1	1.2	1.2	1.2

Table 16: Operating Data

DATE	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01	15-Aug-01
PHASE	3	3	3	4	5	5	6	6	6
TIME	0830	0930	1030	1130	1230	1330	1430	1530	1630
%NITROGEN	63.29%	62.78%	62.95%	64.02%	64.99%	64.86%	65.88%	65.54%	65.35%
%OXYGEN	9.84%	10.12%	9.88%	9.81%	10.06%	9.96%	10.13%	10.00%	9.80%
%OXYGEN (DRY)	12.30%	12.70%	12.40%	12.10%	12.20%	12.10%	12.10%	12.00%	11.80%
%CARBON DIOXIDE	6.81%	6.76%	6.84%	7.21%	7.40%	7.47%	7.63%	7.77%	7.89%
%WATER	20.06%	20.34%	20.33%	18.96%	17.54%	17.71%	16.37%	16.69%	16.96%
CALCINER SPEED - RPM	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
MATERIAL RESIDENCE TIME (min):	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
EMISSIONS:									
FILTER EXIT FLOW (SCFM):	247.8	246.9	247.1	247.1	246.8	247.1	247.1	247.1	247.3
STATIC PRESS-"WG	-1.9	-1.9	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
DIFFER. PRESS-"WG	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
AIR TEMP.-°F	237	242	241	241	243	241	241	241	240
FILTER EXIT FLOW (DSCFM):	205.7	203.9	207.8	209.2	209.4	209.8	209.7	210.2	210.3
SO2 (LB/HR):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO2 (LB/ST TRONA):	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NOx (LB/HR as NO2):	0.0931	0.1081	0.1359	0.2151	0.2631	0.2501	0.2800	0.2776	0.2732
NOx (LB/ST TRONA):	0.4542	0.4969	0.6967	1.1534	1.4109	1.3410	1.5015	1.4886	1.4649
CO (LB/HR):	0.0592	0.0519	0.0580	0.0722	0.0585	0.0531	0.0568	0.0776	0.3463
CO (LB/ST TRONA):	0.2887	0.2385	0.2973	0.3874	0.3136	0.2847	0.3048	0.4158	1.8569
THC (LB/HR as C3H8):	0.0185	0.0181	0.0209	0.0201	0.0189	0.0183	0.0182	0.0184	0.0192
THC (LB/ST TRONA):	0.0904	0.0832	0.1069	0.1080	0.1012	0.0983	0.0975	0.0985	0.1032
CH4 (LB/HR):	0.0014	0.0011	0.0015	0.0010	0.0011	0.0010	0.0011	0.0016	0.0019
CH4 (LB/ST TRONA):	0.0067	0.0050	0.0078	0.0055	0.0061	0.0054	0.0058	0.0084	0.0103
MISC. DATA:									
OFF GAS DAMPER POSITION (%):	6%	6%	6%	6%	6%	6%	6%	6%	6%

Table 17: Operating Data

DATE		15-Aug-01	15-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01
PHASE		7	7	8	8	9	9	10	10
TIME		1730	1815	0945	1045	1200	1300	1400	1430
TEMPERATURE (°F):									
TC#1: COMBUSTION CHAMBER		1761	1750	1933	1949	2055	2062	1762	1765
TC#2: GAS #2 (DIAL1)		720	720	780	750	660	650	710	700
TC#3: GAS #3 (DIAL2)		640	650	680	680	660	650	640	640
TC#4: GAS #4 (DIAL3)		460	460	445	425	400	400	415	415
TC#5: GAS #5 (DIAL4)		505	500	500	470	465	460	470	475
TC#6: GAS OUT		504	503	519	503	502	503	499	502
TC#7: MATERIAL DISCHARGE		403	400	415	386	375	369	394	402
TC#8: FILTER INLET		342	342	351	336	343	342	339	342
TC#9: FILTER EXIT		233	233	221	223	227	228	227	227
PRESSURE ("WG):									
PT#1: COMBUSTION CHAMBER		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PT#2: FEED HOOD		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05
PT#3: DISCHARGE HOOD		-0.2	-0.1	-0.2	-0.25	-0.2	-0.1	-0.2	-0.2
PT#4: FILTER INLET - "WG		-0.6	-0.6	-0.6	-0.5	-0.5	-0.5	-0.6	-0.6
PT#5: FILTER OUTLET - "WG		-1.5	-1.5	-1.5	-1.4	-1.4	-1.4	-1.4	-1.4
GAS ANALYSIS DATA (DRY BASIS):									
COMBUSTION CHAMBER	%O2	8.83%	9.20%	6.74%	7.22%	6.19%	6.35%	9.10%	9.20%
	%COMB	0.08%	0.08%	0.11%	0.12%	0.07%	0.07%	0.11%	0.11%
	ppm CO	592	678	1083	1107	160	136	201	173
CALCINER OUTLET	%O2	14.50%	14.30%	11.80%	11.30%	10.50%	10.60%	13.60%	13.50%
	%COMB	0.08%	0.08%	0.12%	0.13%	0.15%	0.15%	0.13%	0.13%
	ppm CO	370	392	646	692	371	362	190	179
FILTER OUTLET	ppm SO2	0	0	2	2	0	0	0	0
	ppm NOx	155	162	210	225	41	42	21	21
	ppm CO	24	30	77	78	70	78	23	23
	%CO2	4.53%	4.57%	7.33%	7.44%	7.18%	7.12%	4.64%	4.85%
	%O2	16.10%	16.10%	13.22%	13.40%	12.50%	12.60%	15.30%	15.20%
	ppm THC	9	9	2	17	23	22	13	13
	ppm CH4	2	2	0	3	6	7	3	4
AIR HEATER OUTLET:									
MAIN AIR (SCFM):		86.3	86.3	83.9	83.9	87.0	83.5	83.3	83.3
STATIC PRESS-"Hg		1.9	1.9	2.1	2.1	2.1	2.1	2.1	2.1
DIFFER. PRESS-"WG		0.13	0.13	0.12	0.12	0.13	0.12	0.12	0.12
AIR TEMP.-°C		35	35	30	30	32	33	34	34
ATOMIZING AIR (SCFM):		11.2	11.2	11.6	11.6	11.6	11.6	11.6	11.6
METER READING--CFM		6.2	6.2	6	6	6	6	6	6
OUTPUT PRESS-psig		33	33	40	40	40	40	40	40
k FACTOR		1	1	1	1	1	1	1	1
EDUCTOR AIR (SCFM):		7.1	7.1	6.9	6.9	6.9	6.9	6.9	6.9
METER READING--CFM		5.6	5.6	5.4	5.4	5.4	5.4	5.4	5.4
OUTPUT PRESS-psig		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
k FACTOR		0.979	0.971	0.979	0.979	0.979	0.979	0.979	0.979
SUCTION FLOW - SCFM		1	1	1	1	1	1	1	1
OXYGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0
NITROGEN (SCFM):		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--CFM		0	0	0	0	0	0	0	0
OUTPUT PRESS-psig		0	0	0	0	0	0	0	0
k FACTOR		0	0	0	0	0	0	0	0
SULFUR DIOXIDE (SCFM):		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 18: Operating Data

DATE	15-Aug-01	15-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01
PHASE	7	7	8	8	9	9	10	10
TIME	1730	1815	0945	1045	1200	1300	1400	1430
METER READING--CFH	0	0	0	0	0	0	0	0
OUTPUT PRESS-psig	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0
SO2 INJECTION (LB/HR):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LB SO2/LB TRONA FEED:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WATER (SCFM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METER READING--GPH	0	0	0	0	0	0	0	0
k FACTOR	0	0	0	0	0	0	0	0
TOTAL INPUT (SCFM):	104.6	104.5	102.3	102.3	105.5	101.9	101.8	101.8
TRONA FEED (LB/HR):	260.0	260.0	435.0	415.0	570.0	588.0	355.0	355.0
TRONA FEED (STPH):	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.2
NATURAL GAS (SCFM):	2.8	2.8	3.3	3.0	8.3	8.3	6.6	6.6
METER READING--CFM	1.5	1.5	1.75	1.58	4.55	4.55	3.5	3.5
OUTPUT PRESS-psig	16	16	16	16	14	14	16	16
k FACTOR	1	1	1	1	1	1	1	1
NATURAL GAS (BTU/HR LHV):	156,724	156,724	182,845	165,083	459,651	459,651	365,690	365,690
COAL (LB/HR):	15.3	15.3	25.5	24.3	0.0	0.0	0.0	0.0
COAL (BTU/HR LHV):	182,267	182,267	304,774	290,432	0	0	0	0
COAL RATE (MMBtu/st FEED):	1.402	1.402	1.401	1.400	0.000	0.000	0.000	0.000
% OF MAXIMUM COAL RATE:	100.15%	100.15%	100.09%	99.98%	0.00%	0.00%	0.00%	0.00%
TOTAL FUEL INPUT (BTU/HR LHV):	338,991	338,991	487,619	455,515	459,651	459,651	365,690	365,690
TOTAL FUEL INPUT (MMBTU/st FEED):	2.61	2.61	2.24	2.20	1.61	1.56	2.06	2.06
%NATURAL GAS	46.23%	46.23%	37.50%	36.24%	100.00%	100.00%	100.00%	100.00%
%COAL	53.77%	53.77%	62.50%	63.76%	0.00%	0.00%	0.00%	0.00%
ADJUSTED INPUT (SCFM):	109.2	109.1	108.5	108.1	113.9	110.4	108.5	108.5
ADJUSTED INPUT (ACFM):	457.4	455.0	490.0	491.2	540.5	525.2	454.9	455.5
INLET VELOCITY (FPS):	4.3	4.3	4.6	4.6	5.1	5.0	4.3	4.3
INLET VELOCITY (MPS):	1.3	1.3	1.4	1.4	1.6	1.5	1.3	1.3
FLOW COMPOSITION:								
NITROGEN (SCFM)	82.6	82.6	80.8	80.8	83.3	80.5	80.4	80.4
OXYGEN (SCFM)	9.6	9.6	3.7	4.9	5.2	4.5	7.9	7.9
CARBON DIOXIDE (SCFM)	8.7	8.7	13.1	12.3	8.6	8.6	6.9	6.9
WATER (SCFM)	8.1	8.1	10.7	9.9	16.7	16.7	13.3	13.3
DRY FLOW (DSCFM):	101.0	100.9	97.7	98.1	97.2	93.6	95.2	95.2
%NITROGEN	75.69%	75.69%	74.50%	74.81%	73.15%	72.96%	74.11%	74.11%
%OXYGEN	8.78%	8.78%	3.42%	4.52%	4.60%	4.07%	7.30%	7.30%
%OXYGEN (DRY)	9.50%	9.49%	3.80%	4.98%	5.39%	4.79%	8.32%	8.32%
%CARBON DIOXIDE	8.01%	8.02%	12.11%	11.43%	7.58%	7.83%	6.33%	6.33%
%WATER	7.45%	7.46%	9.88%	9.15%	14.67%	15.15%	12.26%	12.26%
CALCINER EXIT:								
COMBUSTION PRODUCTS (SCFM):*	85.8	85.8	128.1	120.3	137.8	139.3	101.2	101.2
COMBUSTION PRODUCTS (DSCFM):	59.1	59.1	86.3	80.8	80.4	80.7	62.6	62.6
REQUIRED AIR (SCFM):	58.9	58.9	84.7	79.1	80.5	80.5	64.1	64.1
EXCESS AIR (SCFM):	131.8	126.1	110.7	94.2	80.4	82.2	115.0	112.6
TOTAL FLOW (SCFM):	217.6	211.9	238.8	214.5	218.2	221.6	216.2	213.9
TOTAL FLOW (ACFM):	395.7	384.9	441.1	389.7	396.1	402.6	391.2	388.2
FLOW COMPOSITION:								
NITROGEN (SCFM)	150.7	146.2	154.4	136.9	127.2	128.6	141.5	139.6
OXYGEN (SCFM)	27.7	26.5	23.3	19.8	16.9	17.3	24.2	23.7
CARBON DIOXIDE (SCFM)	12.5	12.5	19.3	18.3	16.8	17.0	11.9	11.9
WATER (SCFM)	26.7	26.7	41.7	39.5	57.3	58.6	38.6	38.6
EXIT VELOCITY (FPS):	3.7	3.6	4.2	3.7	3.7	3.8	3.7	3.7
EXIT VELOCITY (MPS):	1.1	1.1	1.3	1.1	1.1	1.2	1.1	1.1

Table 19: Operating Data

DATE	15-Aug-01	15-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01	16-Aug-01
PHASE	7	7	8	8	9	9	10	10
TIME	1730	1815	0945	1045	1200	1300	1400	1430
%NITROGEN	69.28%	69.02%	64.67%	63.85%	58.29%	58.05%	65.45%	65.30%
%OXYGEN	12.73%	12.50%	9.74%	9.23%	7.74%	7.80%	11.17%	11.06%
%OXYGEN (DRY)	14.50%	14.30%	11.80%	11.30%	10.50%	10.60%	13.60%	13.50%
%CARBON DIOXIDE	5.73%	5.88%	8.10%	8.52%	7.68%	7.68%	5.52%	5.58%
%WATER	12.26%	12.59%	17.48%	18.41%	26.28%	26.47%	17.86%	18.05%
CALCINER SPEED - RPM	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
MATERIAL RESIDENCE TIME (min):	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
EMISSIONS:								
FILTER EXIT FLOW (SCFM):	248.6	248.6	250.7	250.4	249.6	249.5	249.6	249.6
STATIC PRESS-"WG	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-2.0
DIFFER. PRESS-"WG	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
AIR TEMP.-°F	233	233	221	223	227	228	227	227
FILTER EXIT FLOW (DSCFM):	221.9	221.9	209.0	210.9	192.3	190.8	211.0	211.0
SO2 (LB/HR):	0.0000	0.0000	0.0042	0.0038	0.0000	0.0000	0.0000	0.0000
SO2 (LB/ST TRONA):	0.0000	0.0000	0.0191	0.0182	0.0000	0.0000	0.0000	0.0000
NOx (LB/HR as NO2):	0.2455	0.2566	0.3133	0.3388	0.0562	0.0571	0.0323	0.0320
NOx (LB/ST TRONA):	1.8887	1.9740	1.4407	1.6326	0.1971	0.1943	0.1817	0.1802
CO (LB/HR):	0.0236	0.0290	0.0697	0.0715	0.0589	0.0647	0.0211	0.0211
CO (LB/ST TRONA):	0.1812	0.2231	0.3203	0.3448	0.2066	0.2200	0.1189	0.1187
THC (LB/HR as C3H8):	0.0139	0.0142	0.0022	0.0238	0.0302	0.0281	0.0182	0.0190
THC (LB/ST TRONA):	0.1070	0.1096	0.0103	0.1145	0.1060	0.0957	0.1023	0.1071
CH4 (LB/HR):	0.0010	0.0011	0.0001	0.0014	0.0027	0.0032	0.0017	0.0019
CH4 (LB/ST TRONA):	0.0081	0.0082	0.0004	0.0065	0.0094	0.0108	0.0094	0.0109
MISC. DATA:								
OFF GAS DAMPER POSITION (%):	6%	6%	6%	6%	6%	6%	6%	6%

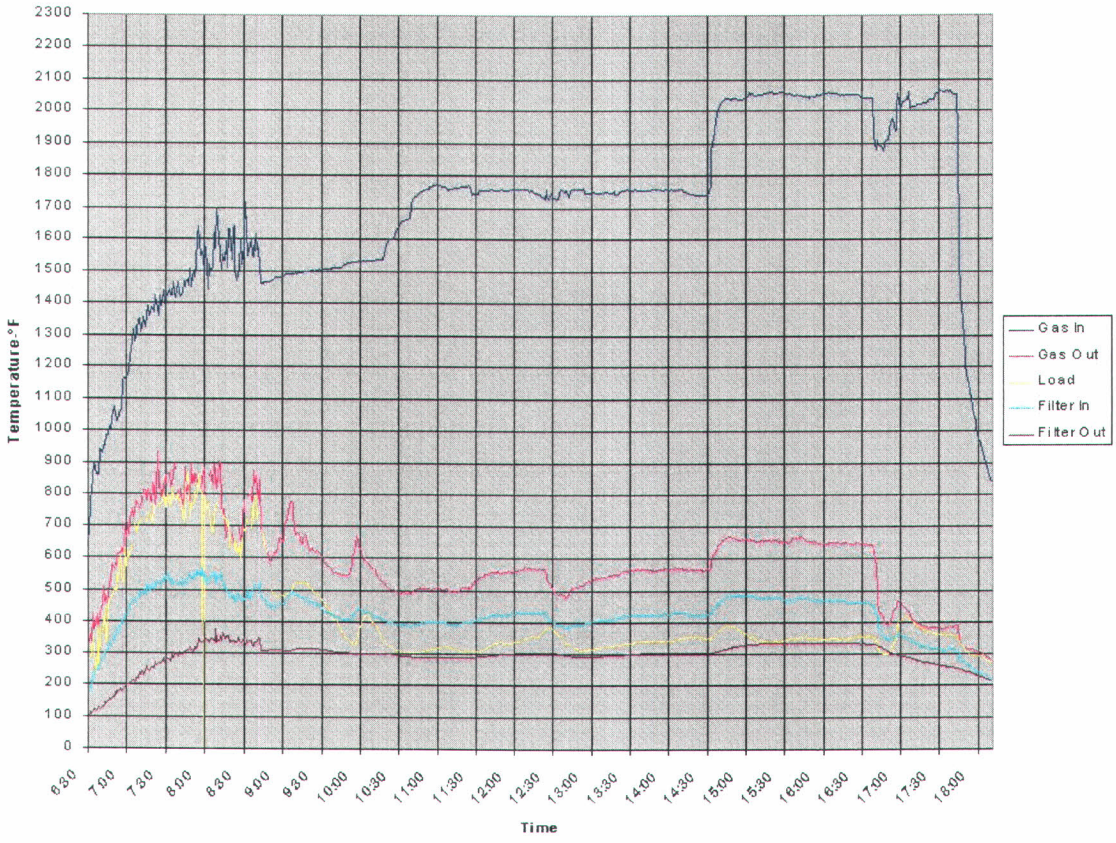


Figure 15: System Temperature Profile-13Aug

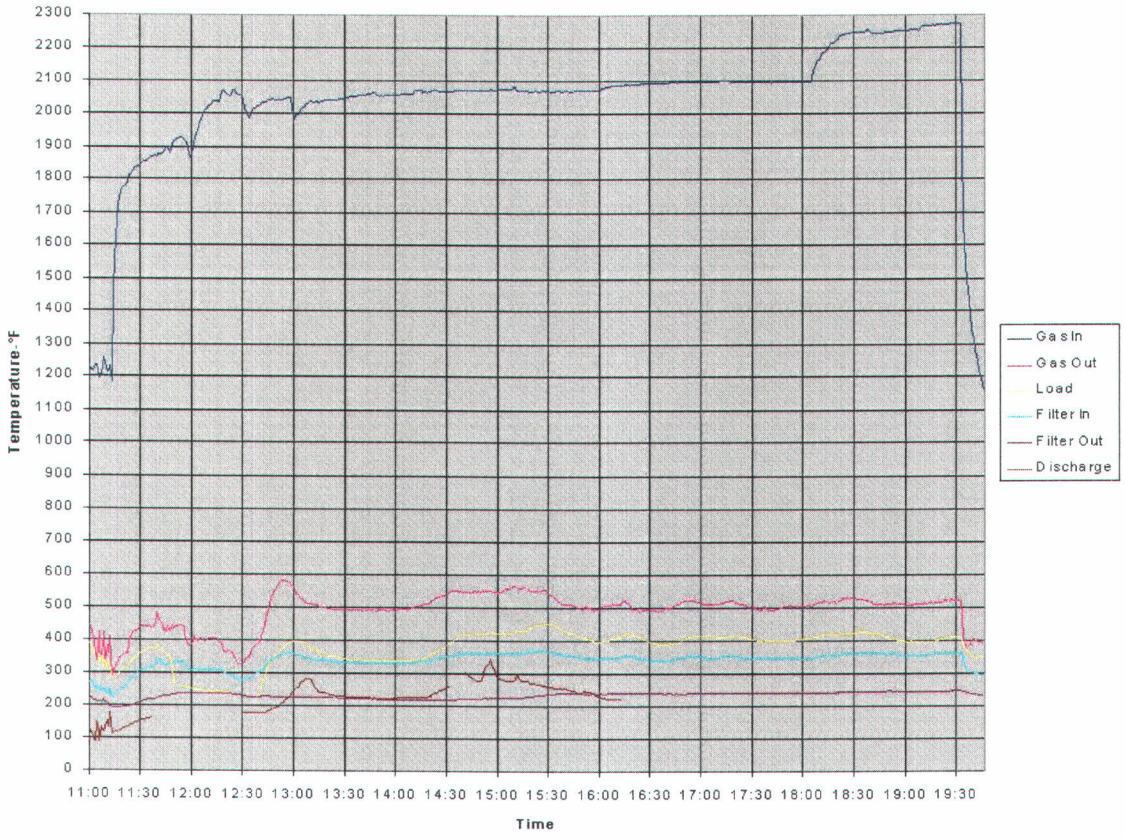


Figure 16: System Temperature Profile-14Aug

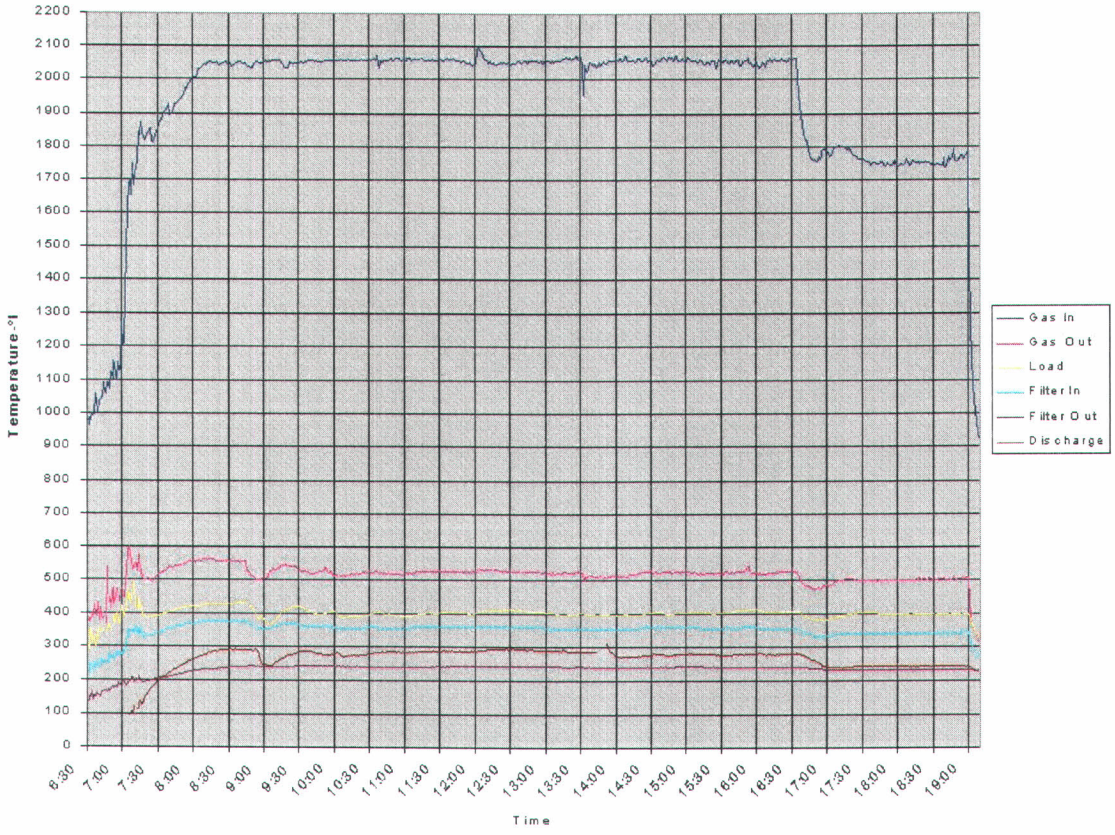


Figure 17: System Temperature Profile-15Aug

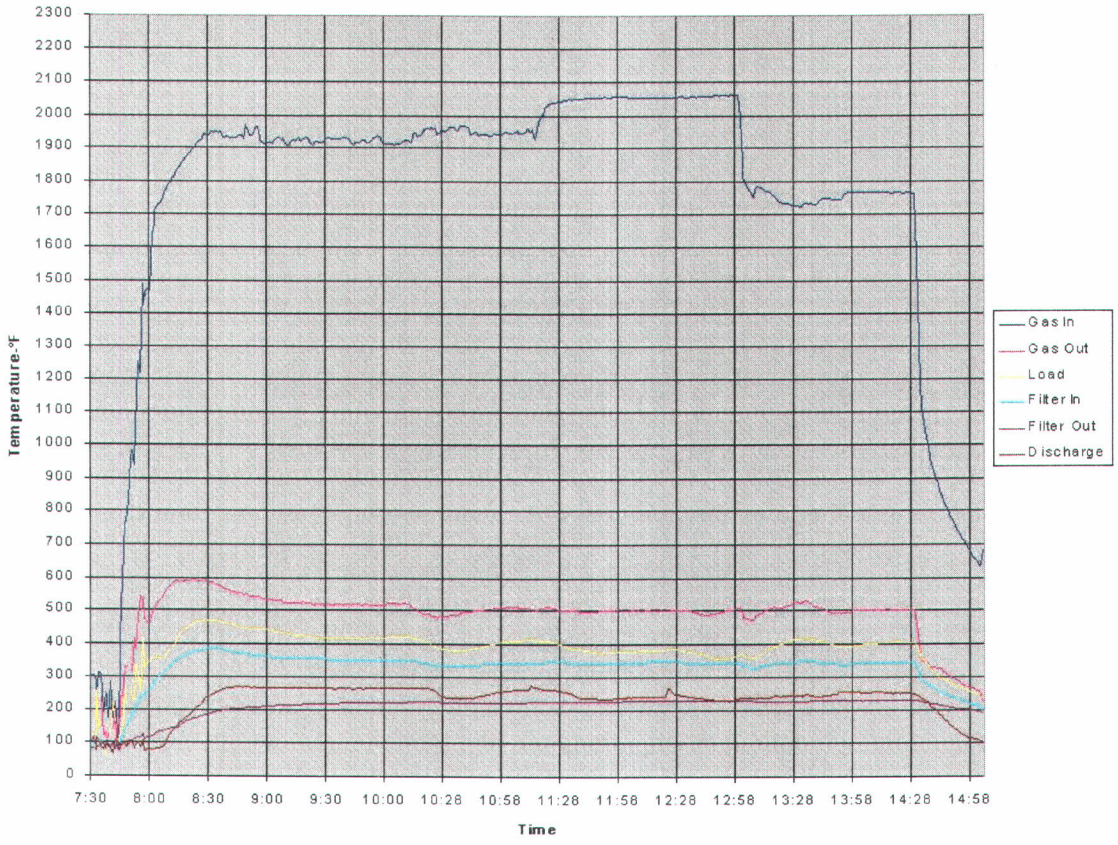


Figure 18: System Temperature Profile-16Aug

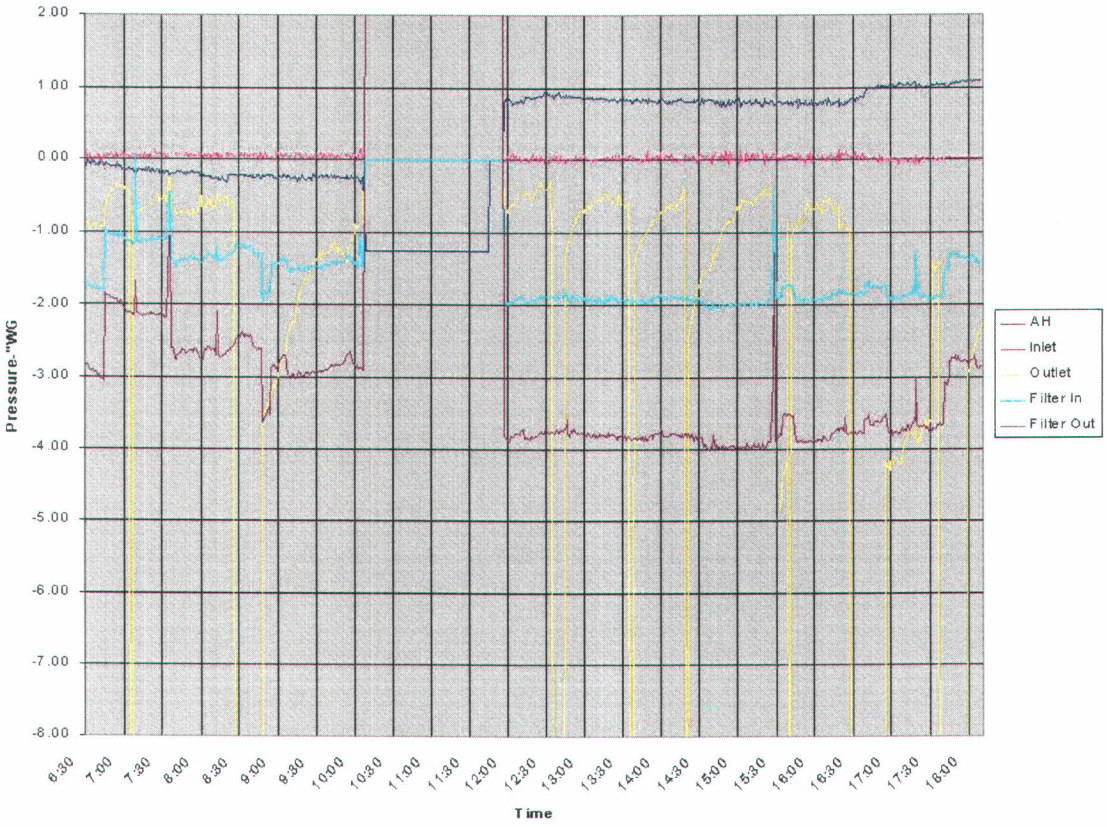


Figure 19: System Pressure Profile-13Aug

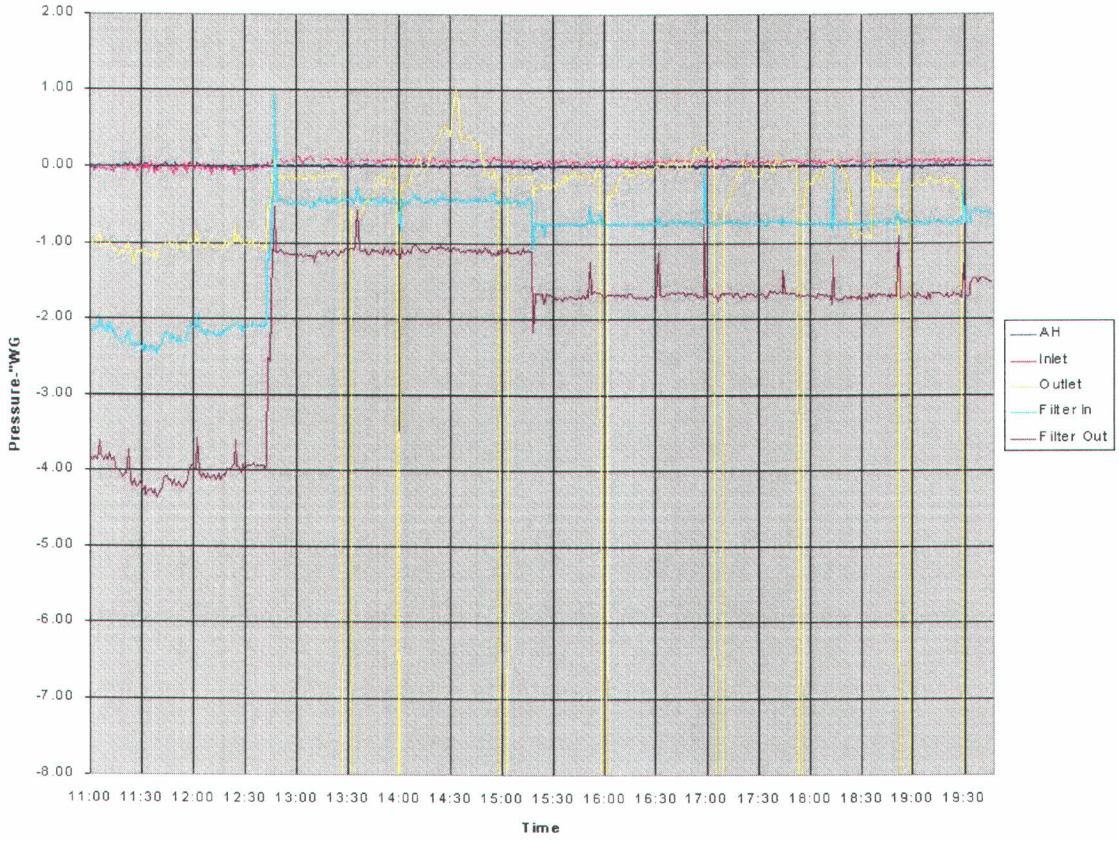


Figure 20: System Pressure Profile-14Aug

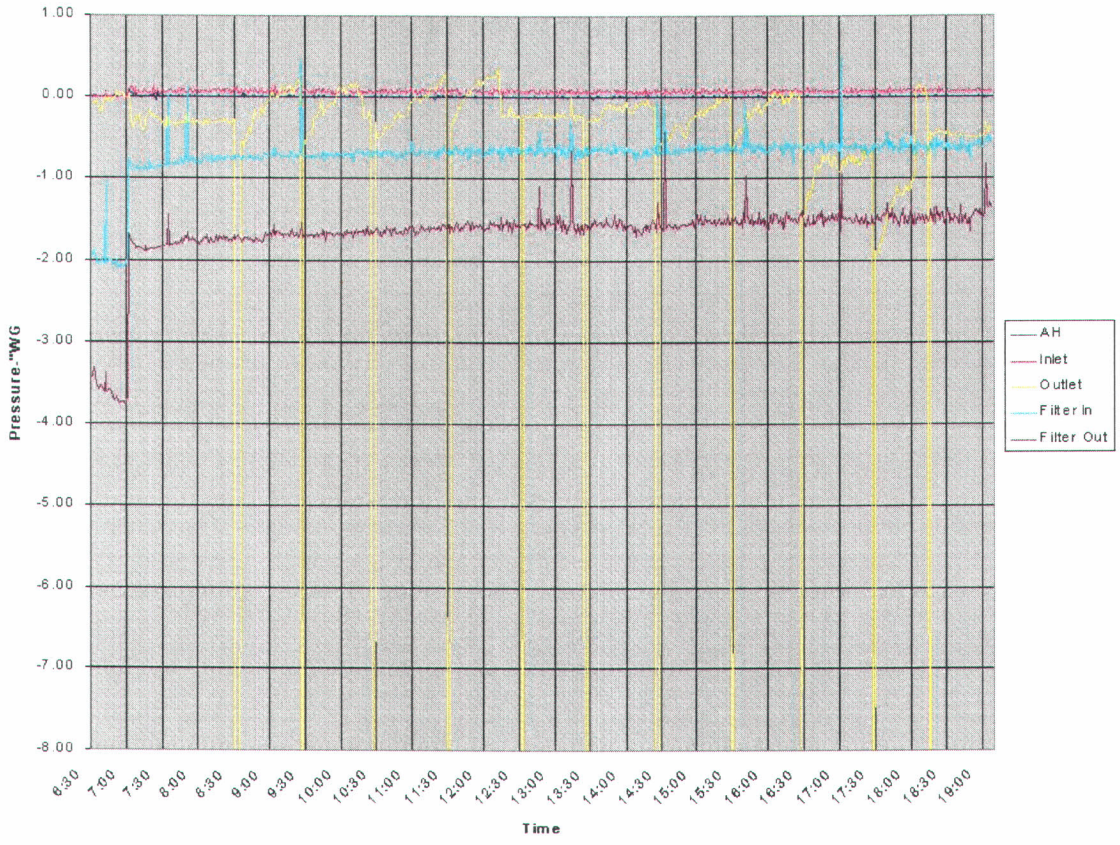


Figure 21: System Pressure Profile-15Aug

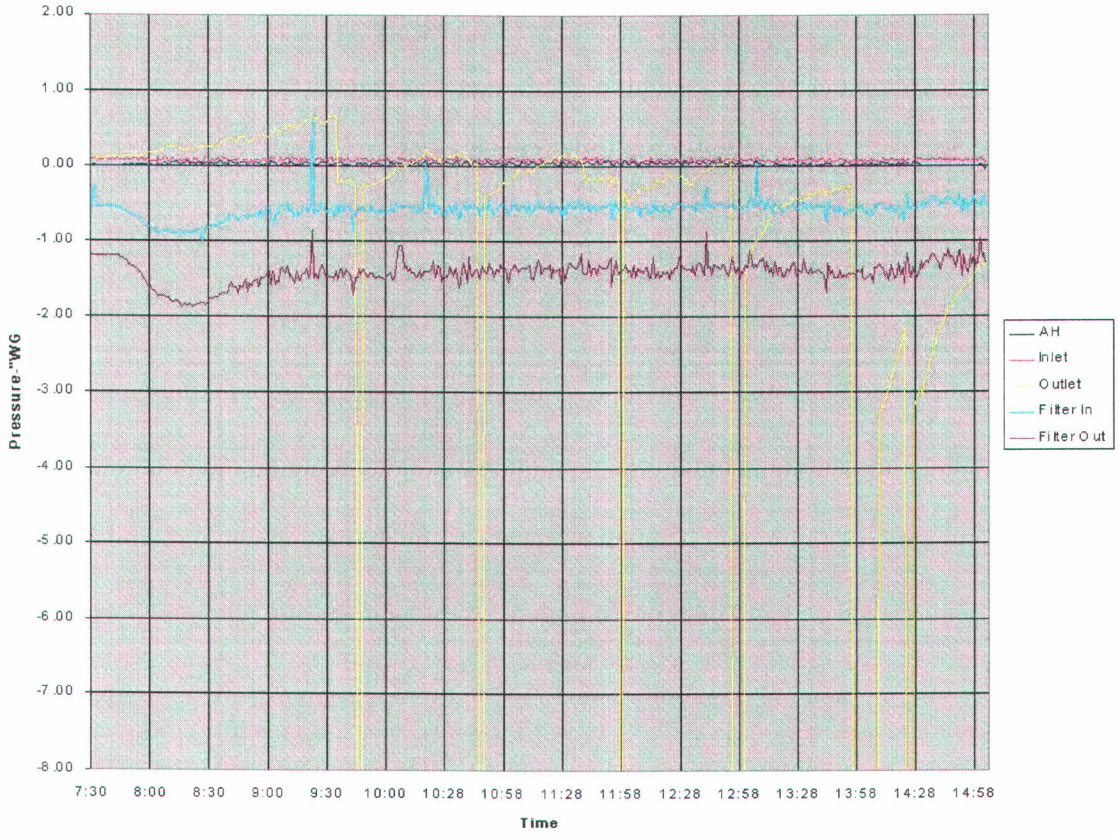


Figure 22: System Pressure Profile-16Aug

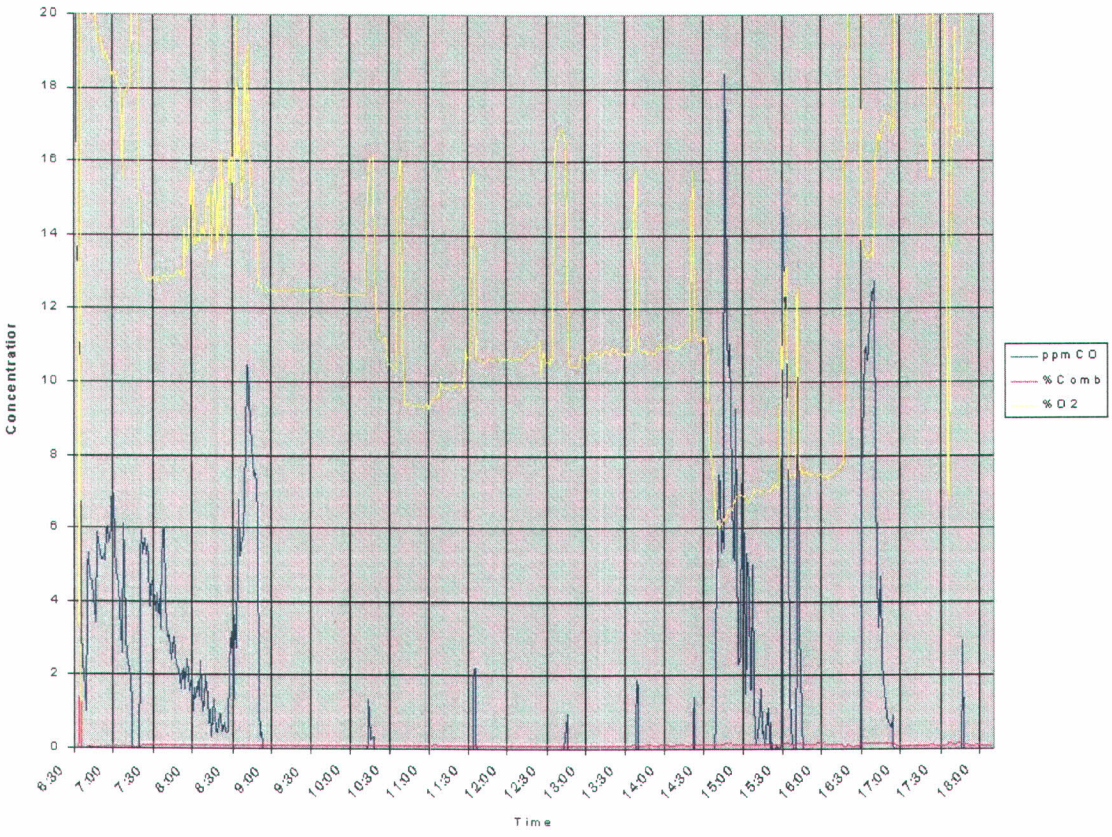


Figure 23: Teledyne Analyzer Data-13Aug

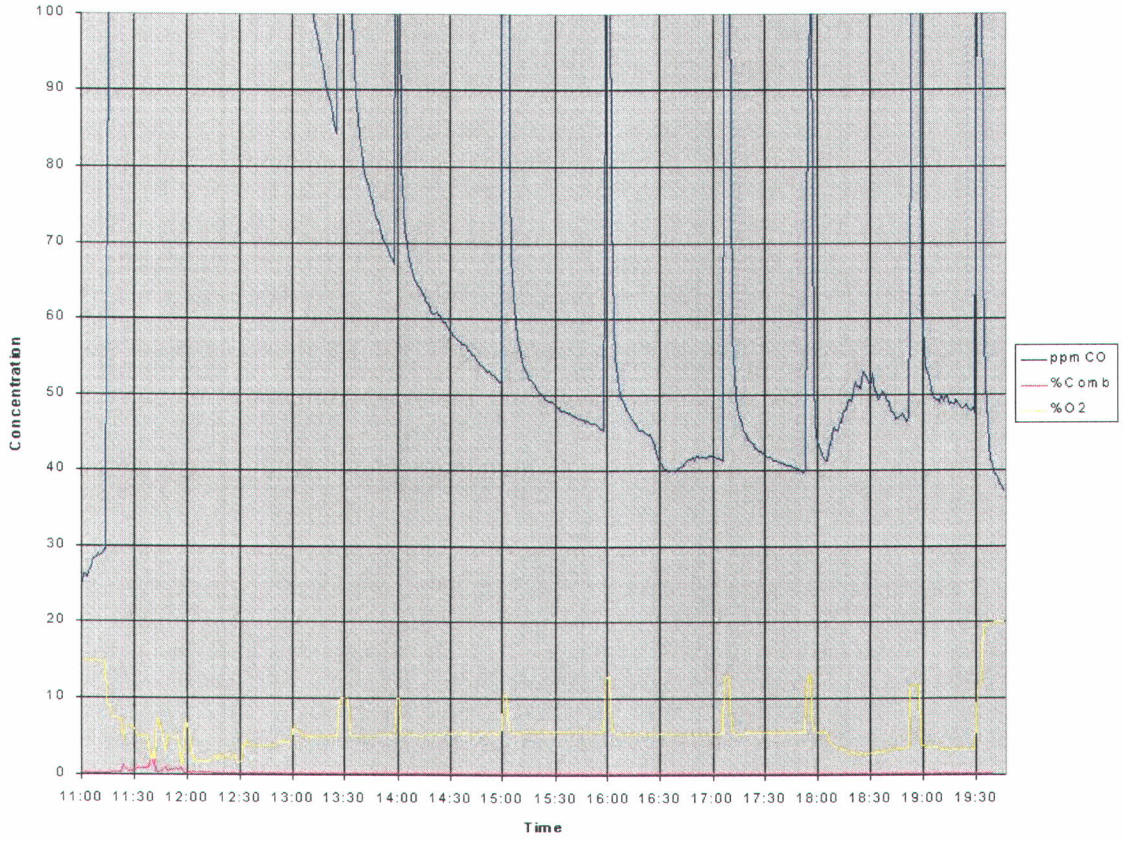


Figure 24: Teledyne Analyzer Data-14Aug

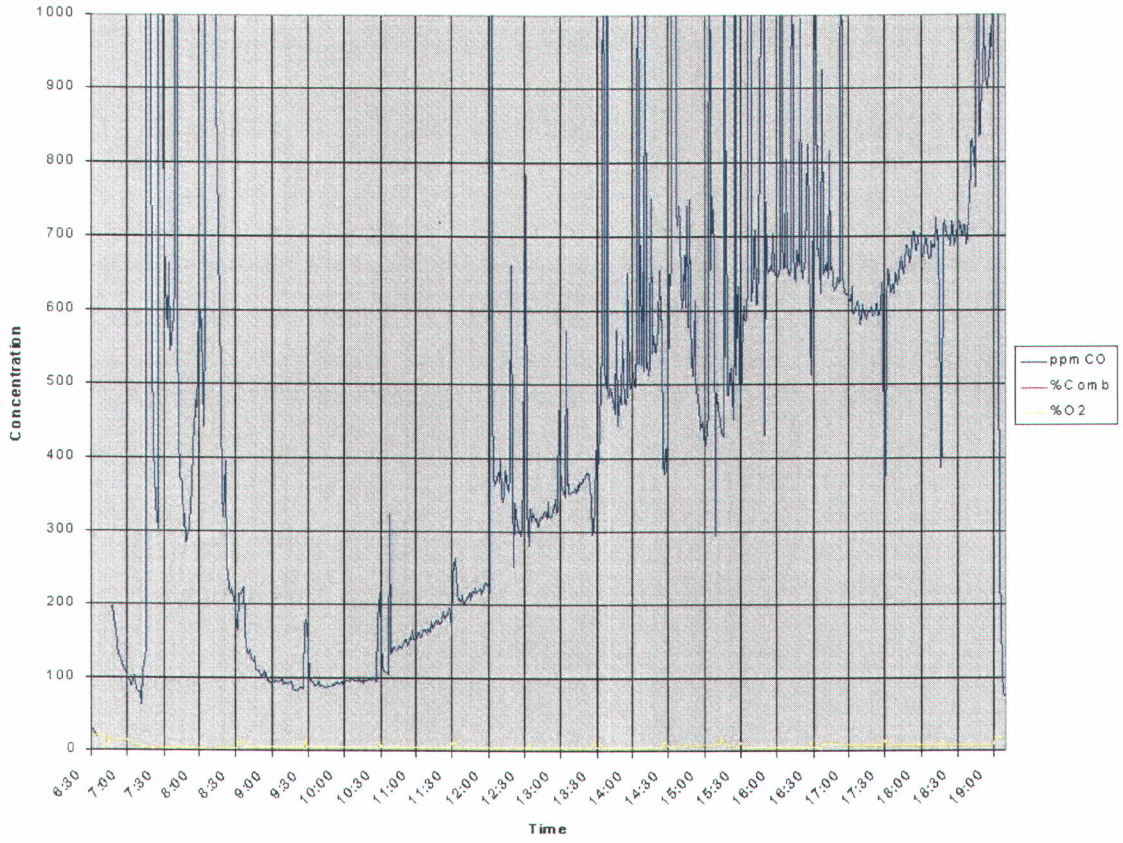


Figure 25: Teledyne Analyzer Data-15Aug

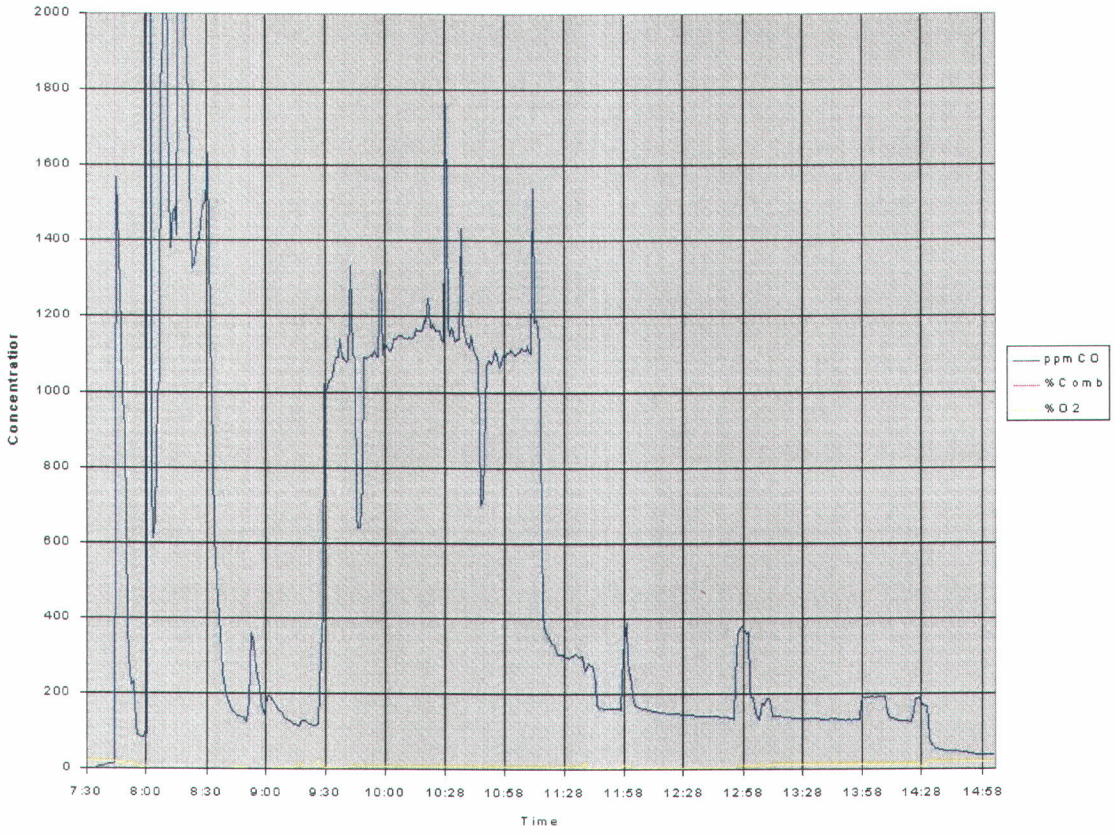


Figure 26: Teledyne Analyzer Data-16Aug

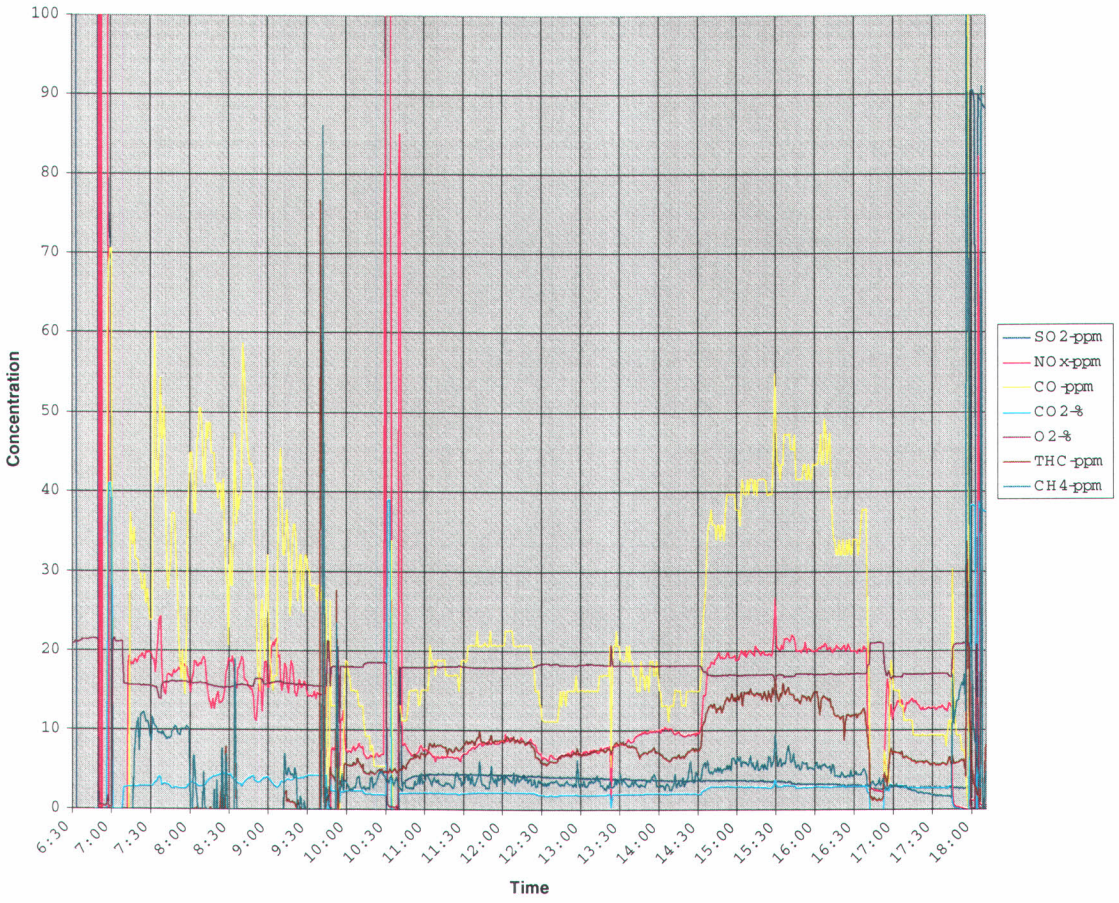


Figure 27: Filter Exit Gas Analysis-13Aug

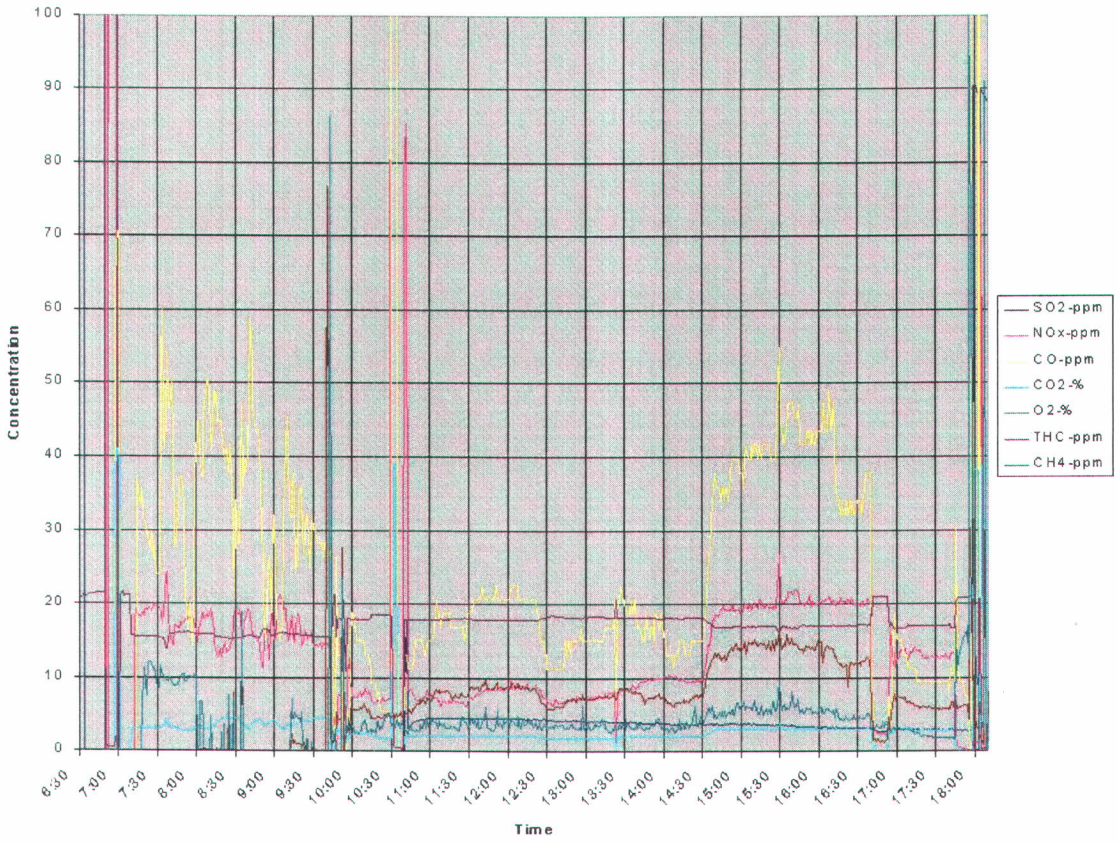


Figure 28: Filter Exit Gas Analysis-14Aug

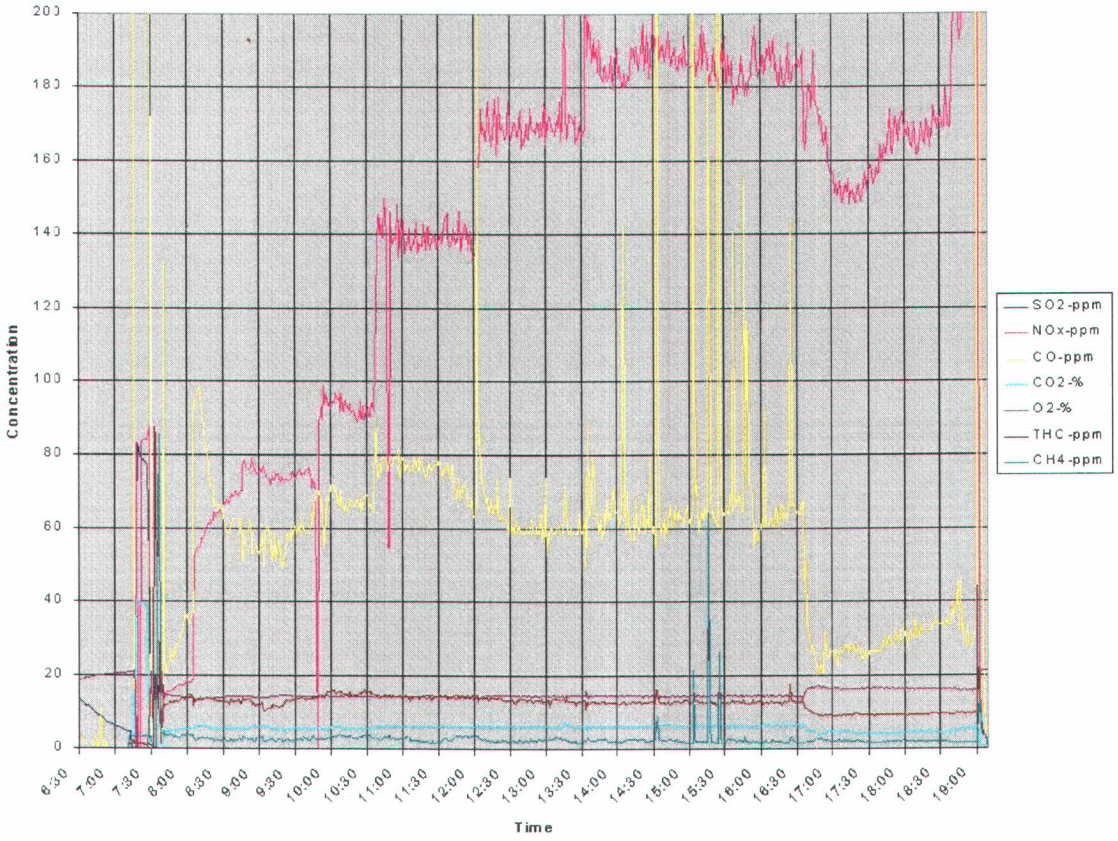


Figure 29: Filter Exit Gas Analysis-15Aug

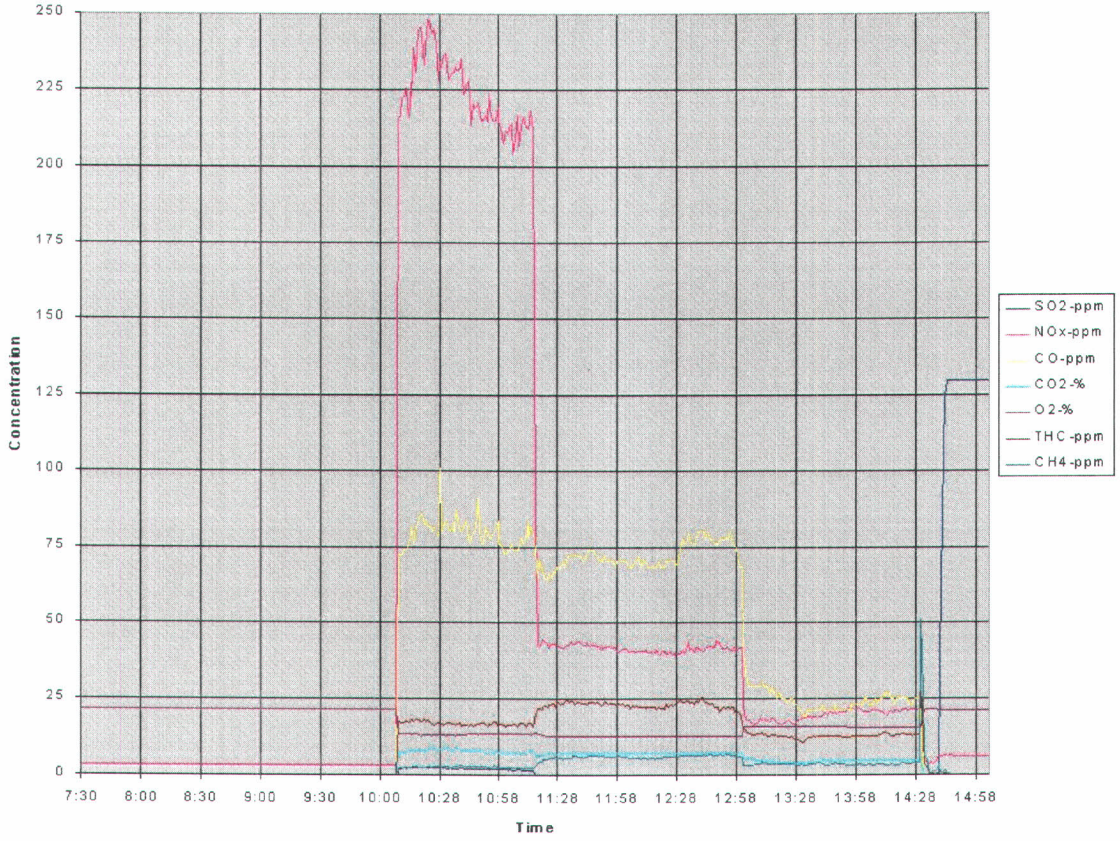


Figure 30: Filter Exit Gas Analysis-16Aug

Table 20: Heavy Metals Data

Natural Gas
Sample Volume: 92
Flowrate 256

		Laboratory Data							
		Front Half Sample (ug)	Front Half Blank (ug)		Back Half Sample (ug)	Back Half Blank (ug)	Sample Total (ug)	Concentration ppm	Mass Rate lb/hr
Arsenic	As	7.45	0	<	0	0	7.45	9.18E-03	2.7426E-06
Cadmium	Cd	1.53	0	<	0	0	1.53	1.26E-03	5.6324E-07
Lead	Pb	169	0		1.11	0.679	169.431	7.55E-02	6.2372E-05
Mercury	Hg	0.4	0		2	0	2.4	1.10E-03	8.8351E-07

Coal Firing
Sample Volume: 85.2
Flowrate 257

		Laboratory Data							
		Front Half Sample (ug)	Front Half Blank (ug)		Back Half Sample (ug)	Back Half Blank (ug)	Sample Total (ug)	Concentratio ppm	Mass Rate lb/hr
Arsenic	As	8.33	0	<	0	0	8.33	1.11E-02	3.3242E-06
Cadmium	Cd	0.444	0	<	0	0	0.444	3.94E-04	1.1809E-07
Lead	Pb	123	0		0.843	0.679	123.164	5.93E-02	1.7772E-05
Mercury	Hg	0	0		3	0	3	1.49E-03	4.4716E-07

Table 21: Heat Balance-Phase 1

HEAT IN					BTU/HR	kcal/hr	%
1 Air Input:	473 lb/hr	8.8 btu/lb			4,144	1,044	1.09%
2 Natural Gas:	402 scfh	924 btu/SCF LHV			371,448	93,605	97.44%
3 Leak Air:	281 lb/hr	8.8 btu/lb			2,460	620	0.65%
4 Feed @ 70°F:	345 lb/hr	9.1 btu/lb			3,146	793	0.83%
~~TOTAL IN~~					~~381,199~~	~~96,062~~	~~100.0%~~
HEAT OUT					**BTU/HR**	**kcal/hr**	**%**
1 Radiation & Convection:					**158,939**	**40,053**	**40.93%**
	Air Heater:				96,955	24,433	24.97%
	Rotary Calciner Shell:				48,512	12,225	12.49%
	Hoods:				13,472	3,395	3.47%
2 Calciner Off Gas @	505 °F						
CO2		47.7 lb/hr x		99.7 btu/lb	4,750	1,197	1.22%
H2O		37.7 lb/hr x		223.6 btu/lb	8,426	2,123	2.17%
N2		579.9 lb/hr x		116.6 btu/lb	67,620	17,040	17.42%
3 Excess O2 @	505 °F:	107.3 lb/hr x		104.8 btu/lb	11,247	2,834	2.90%
4 Calciner Product @	401 °F:	227.0 lb/hr x		88.6 btu/lb	20,103	5,066	5.18%
5 Fines @	505 °F:	30.0 lb/hr x		113.5 btu/lb	3,406	858	0.88%
6 Feed Moisture:	505 °F:	1.7 lb/hr x		1,173.6 btu/lb	1,984	500	0.51%
7 Heat of Reaction:		344.0 lb/hr dry feed x		325 btu/lb	111,800	28,174	28.79%
~~TOTAL OUT~~					~~388,274~~	~~97,845~~	~~100.0%~~

1.9% difference between the total heat in and the total heat out

Table 22: Heat Balance-Phase 6

HEAT IN				BTU/HR	kcal/hr	%
1 Air Input:	470 lb/hr	8.8	btu/lb	4,121	1,038	0.89%
2 Natural Gas:	204 scfh	924	btu/SCF LHV	188,496	47,501	40.90%
3 Coal:	22 lb/hr	11,952	btu/lb LHV	261,749	65,961	56.79%
4 Leak Air:	354 lb/hr	8.8	btu/lb	3,101	782	0.67%
5 Feed @ 70°F:	373 lb/hr	9.1	btu/lb	3,402	857	0.74%
~~TOTAL IN~~				~~460,869~~	~~116,139~~	~~100.0%~~
HEAT OUT				**BTU/HR**	**kcal/hr**	**%**
1 Radiation & Convection:				**174,800**	**44,050**	**39.18%**
Air Heater:				92,336	23,269	20.70%
Rotary Calciner Shell:				65,677	16,551	14.72%
Hoods:				16,787	4,230	3.76%
2 Calciner Off Gas @	526 °F					
CO2		117.5 lb/hr x	104.5 btu/lb	12,279	3,094	2.75%
H2O		103.1 lb/hr x	233.7 btu/lb	24,096	6,072	5.40%
N2		630.1 lb/hr x	121.9 btu/lb	76,805	19,355	17.22%
3 Excess O2 @	526 °F:	96.0 lb/hr x	109.9 btu/lb	10,558	2,661	2.37%
4 Calciner Product @	406 °F:	219.0 lb/hr x	89.8 btu/lb	19,657	4,954	4.41%
5 Fines @	526 °F:	30.6 lb/hr x	118.6 btu/lb	3,628	914	0.81%
6 Feed Moisture:	526 °F:	1.1 lb/hr x	1,183.7 btu/lb	1,280	323	0.29%
7 Coal Moisture:	526 °F:	1.8 lb/hr x	1,180.8 btu/lb	2,129	536	0.48%
8 Heat of Reaction:		371.9 lb/hr dry feed x	325 btu/lb	120,873	30,460	27.10%
~~TOTAL OUT~~				~~446,106~~	~~112,419~~	~~100.0%~~

-3.2% difference between the total heat in and the total heat out

Table 23: Natural Gas Composition

	VOL%
CO2	1.09%
N2	0.42%
CH4	95.33%
C2H6	2.34%
C3H8	0.46%
(CH3)2CHCH3	0.09%
C3H10	0.10%
(CH3)2CHCH2CH3	0.04%
C5H12	0.03%
CH3(CH2)4CH3	1.09%
H2S	1/3 GM PER 100 FT3
TOTAL SULFUR	4 GRAMS PER 100 FT3
NET HEAT VALUE	924 BTU/FT3
DENSITY (lb/ft3 @ STP)	0.0475
FT3 CO2 / FT3 FUEL	1.042
FT3 H2O / FT3 FUEL	2.016
FT3 N2 / FT3 FUEL	7.679
FT3 AIR REQ / FT3 FUEL	9.714

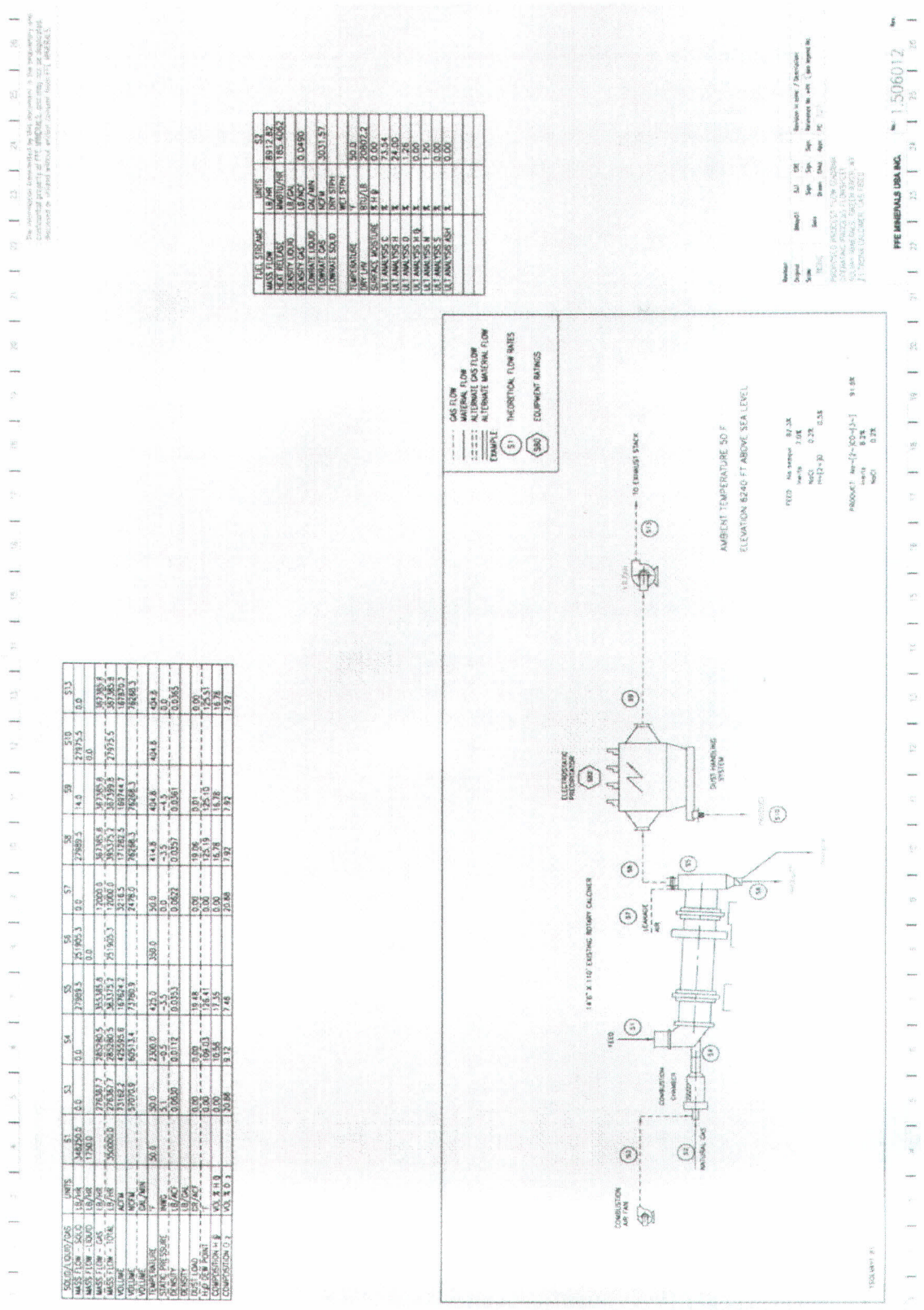


Figure 31: Commercial PFD-Calciner #1 Gas Fired

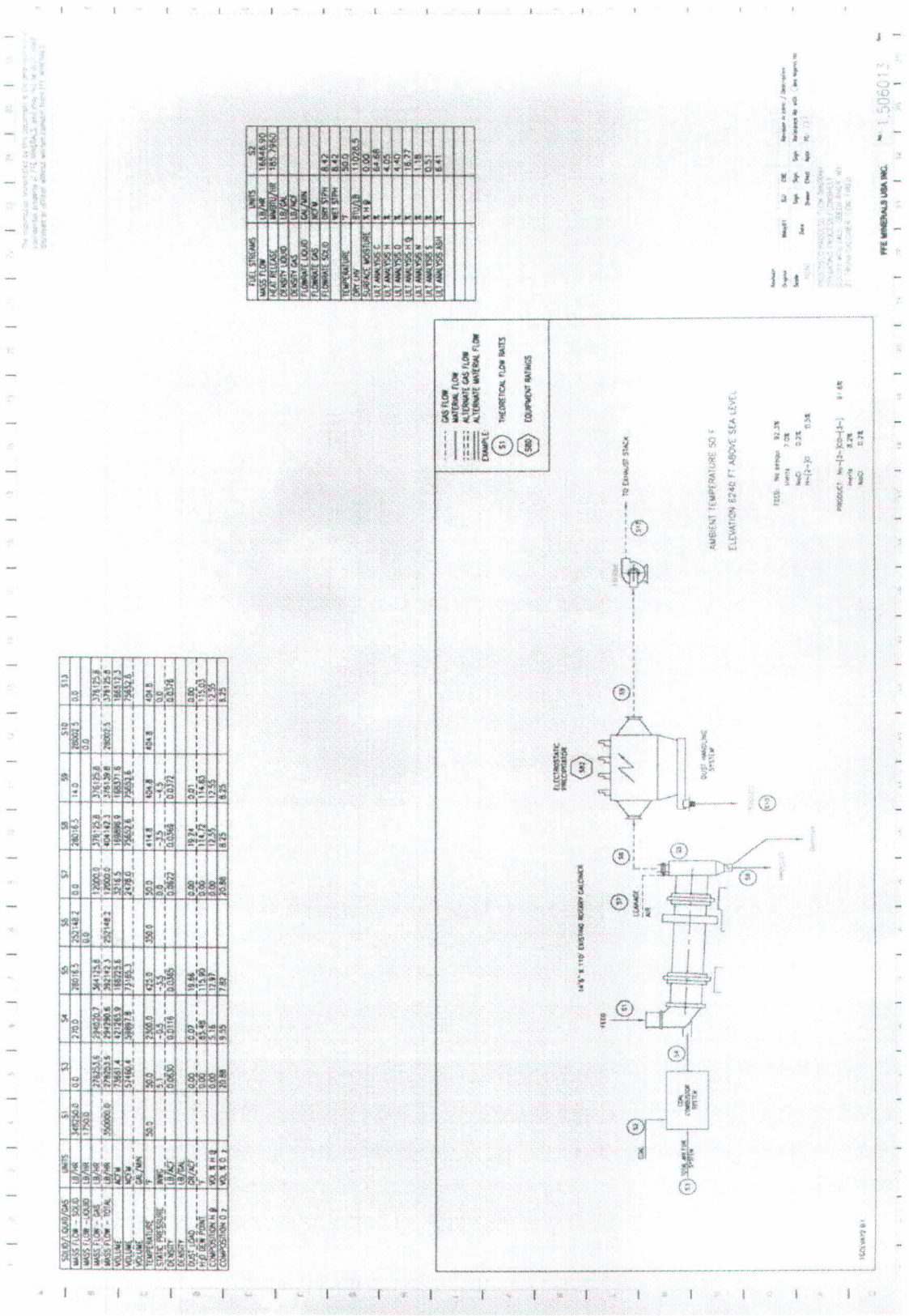


Figure 32: Commercial PFD-Calciner #1 Coal Fired

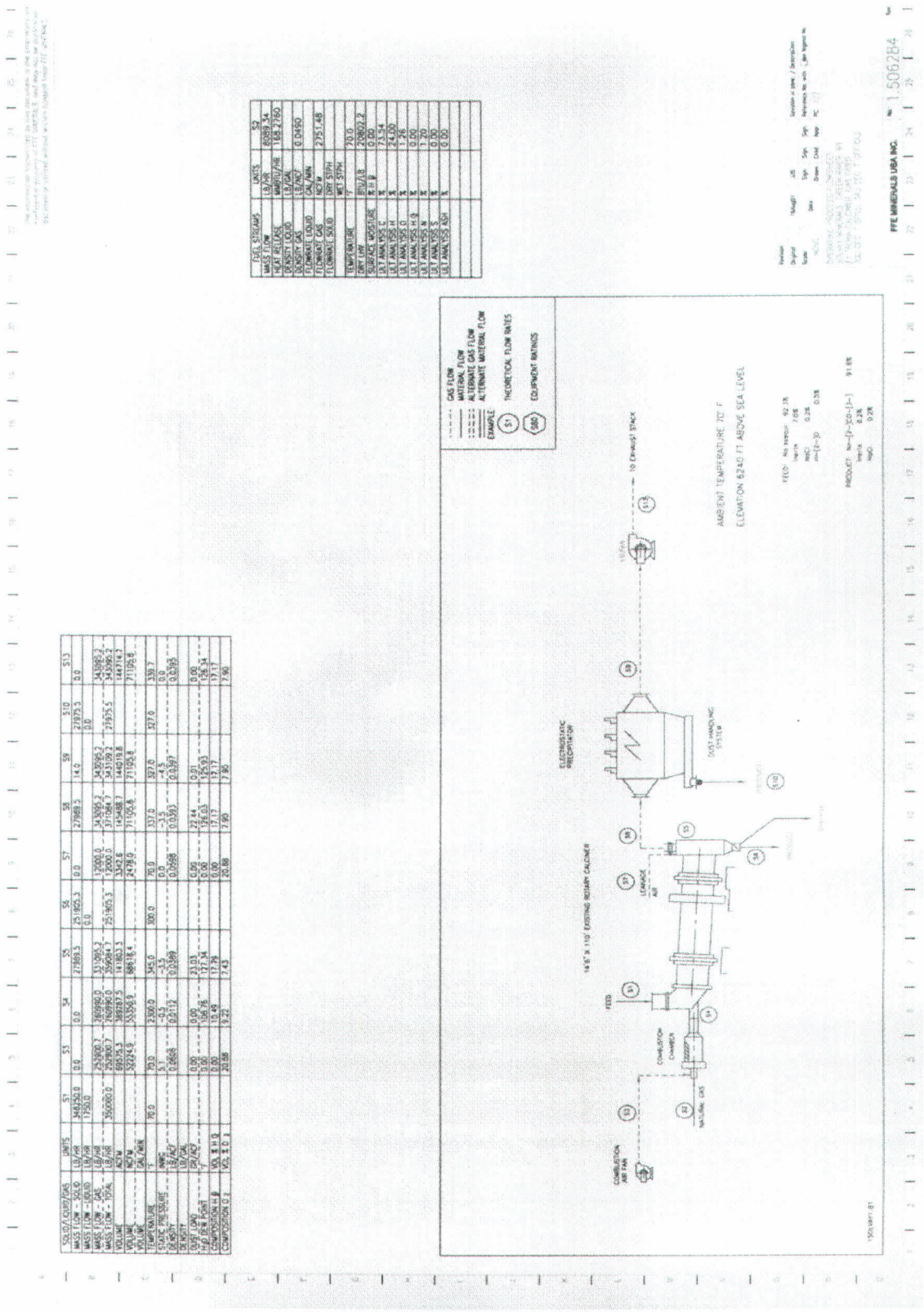


Figure 33: Commercial PFD-300°F Spill

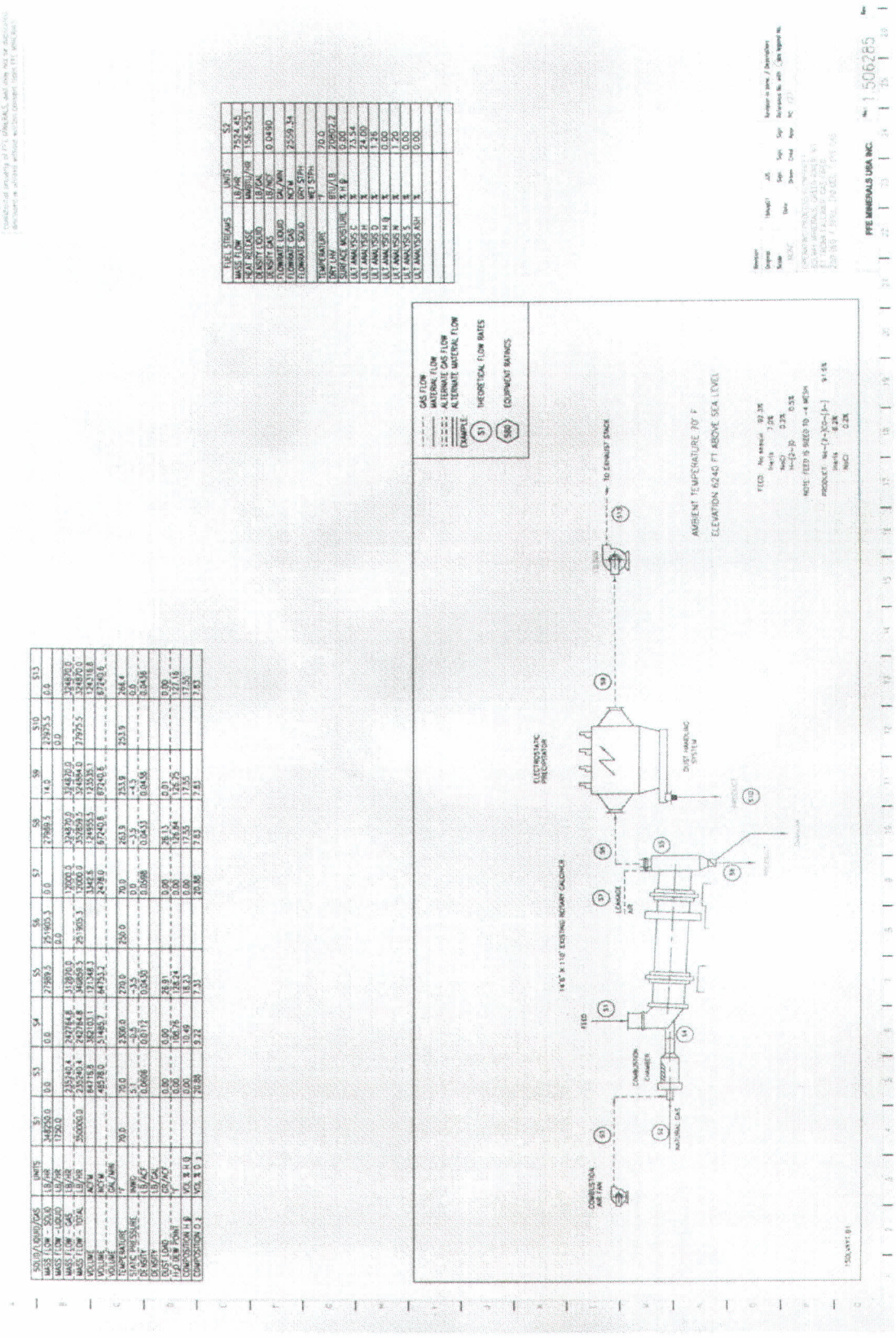


Figure 34: Commercial PFD-250°F Spill

Table 24: Sieve Analysis-Composite Feed "As Received"

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Trona Composite Feed (as received) 13Aug, start-1600 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	277.3 g	
Moisture as Rec'd.:	0.29%		Bulk Density:	82.80 #/cf (wet)	
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min		Bulk Density:	#/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	4.6	1.7	3/8 inch	1.7	98.3
-3/8 +¼ inch	33.8	12.2	¼ inch	13.8	86.2
-¼ +4 mesh	33.0	11.9	4 mesh	25.7	74.3
-4 +6 mesh	37.6	13.6	6 mesh	39.3	60.7
-6 +8 mesh	30.6	11.0	8 mesh	50.3	49.7
-8 +12 mesh	21.5	7.8	12 mesh	58.1	41.9
-12 +16 mesh	15.9	5.7	16 mesh	63.8	36.2
-16 +20 mesh	13.8	5.0	20 mesh	68.8	31.2
-20 +30 mesh	86.5	31.2	30 mesh	100.0	0.0
-30 +40 mesh	0.0	0.0	40 mesh	100.0	0.0
-40 +50 mesh	0.0	0.0	50 mesh	100.0	0.0
-50 +70 mesh	0.0	0.0	70 mesh	100.0	0.0
-70 +100 mesh	0.0	0.0	100 mesh	100.0	0.0
-100 +140 mesh	0.0	0.0	140 mesh	100.0	0.0
-140 +170 mesh	0.0	0.0	170 mesh	100.0	0.0
-170 +200 mesh	0.0	0.0	200 mesh	100.0	0.0
-200 +325 mesh	0.0	0.0	325 mesh	100.0	0.0
-325 mesh	0.0	0.0			
Total	277.3	98.3			

SIGNED: Les Dutt

DATE: 08/13/2001

Table 25: Sieve Analysis-Composite Feed-14Aug (after crushing)

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Composite Feed (after crushing) 14Aug, 1715 hr	Was Screen Sample Dried?	
		Yes: X	No:
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	244.6 g
Moisture as Rec'd.:	0.37%	Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	75.60 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.6	0.7	4 mesh	0.7	99.3
-4 +6 mesh	20.4	8.3	6 mesh	9.0	91.0
-6 +8 mesh	22.6	9.2	8 mesh	18.2	81.8
-8 +12 mesh	19.3	7.9	12 mesh	26.1	73.9
-12 +16 mesh	27.1	11.1	16 mesh	37.2	62.8
-16 +20 mesh	21.4	8.7	20 mesh	46.0	54.0
-20 +30 mesh	16.0	6.5	30 mesh	52.5	47.5
-30 +40 mesh	11.4	4.7	40 mesh	57.2	42.8
-40 +50 mesh	9.3	3.8	50 mesh	61.0	39.0
-50 +70 mesh	9.1	3.7	70 mesh	64.7	35.3
-70 +100 mesh	9.6	3.9	100 mesh	68.6	31.4
-100 +140 mesh	9.0	3.7	140 mesh	72.3	27.7
-140 +170 mesh	6.4	2.6	170 mesh	74.9	25.1
-170 +200 mesh	6.5	2.7	200 mesh	77.6	22.4
-200 +325 mesh	15.9	6.5	325 mesh	84.1	15.9
-325 mesh	39.0	15.9			
Total	244.6	100.0			

SIGNED: Les Dutt

DATE: 08/17/2001

Table 26: Sieve Analysis-Composite Feed-14Aug (after crushing)

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Composite Feed (after crushing) 14Aug, 1800-1930 hr	Was Screen Sample Dried?	
		Yes: X	No:
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	269.0 g
Moisture as Rec'd.:	0.37%	Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	78.40 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.3	0.5	4 mesh	0.5	99.5
-4 +6 mesh	27.1	10.1	6 mesh	10.6	89.4
-6 +8 mesh	32.1	11.9	8 mesh	22.5	77.5
-8 +12 mesh	30.4	11.3	12 mesh	33.8	66.2
-12 +16 mesh	34.2	12.7	16 mesh	46.5	53.5
-16 +20 mesh	23.8	8.8	20 mesh	55.4	44.6
-20 +30 mesh	16.0	5.9	30 mesh	61.3	38.7
-30 +40 mesh	10.6	3.9	40 mesh	65.2	34.8
-40 +50 mesh	8.6	3.2	50 mesh	68.4	31.6
-50 +70 mesh	8.3	3.1	70 mesh	71.5	28.5
-70 +100 mesh	8.6	3.2	100 mesh	74.7	25.3
-100 +140 mesh	8.5	3.2	140 mesh	77.9	22.1
-140 +170 mesh	5.6	2.1	170 mesh	80.0	20.0
-170 +200 mesh	5.5	2.0	200 mesh	82.0	18.0
-200 +325 mesh	14.4	5.4	325 mesh	87.4	12.6
-325 mesh	34.0	12.6			
Total	269.0	100.0			

SIGNED: Les Dutt

DATE: 08/17/2001

Table 27: Sieve Analysis-Composite Feed-15Aug (after crushing)

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Composite Feed (after crushing) 15Aug, Start-1830 hr	Was Screen Sample Dried?	
		Yes: X	No:
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	278.5 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	81.50 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	3.4	1.2	4 mesh	1.2	98.8
-4 +6 mesh	40.7	14.6	6 mesh	15.8	84.2
-6 +8 mesh	32.2	11.6	8 mesh	27.4	72.6
-8 +12 mesh	38.1	13.7	12 mesh	41.1	58.9
-12 +16 mesh	26.3	9.4	16 mesh	50.5	49.5
-16 +20 mesh	18.3	6.6	20 mesh	57.1	42.9
-20 +30 mesh	12.2	4.4	30 mesh	61.5	38.5
-30 +40 mesh	9.4	3.4	40 mesh	64.8	35.2
-40 +50 mesh	9.4	3.4	50 mesh	68.2	31.8
-50 +70 mesh	9.6	3.4	70 mesh	71.7	28.3
-70 +100 mesh	9.3	3.3	100 mesh	75.0	25.0
-100 +140 mesh	8.9	3.2	140 mesh	78.2	21.8
-140 +170 mesh	5.9	2.1	170 mesh	80.3	19.7
-170 +200 mesh	6.4	2.3	200 mesh	82.6	17.4
-200 +325 mesh	16.5	5.9	325 mesh	88.5	11.5
-325 mesh	31.9	11.5			
Total	278.5	100.0			

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DATE: 08/20/2001

Table 28: Sieve Analysis-Product-Phase 1

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 1) 14Aug, 1630 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	154.1 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	58.40 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.3	0.2	4 mesh	0.2	99.8
-4 +6 mesh	9.1	5.9	6 mesh	6.1	93.9
-6 +8 mesh	19.1	12.4	8 mesh	18.5	81.5
-8 +12 mesh	18.8	12.2	12 mesh	30.7	69.3
-12 +16 mesh	19.3	12.5	16 mesh	43.2	56.8
-16 +20 mesh	16.1	10.4	20 mesh	53.7	46.3
-20 +30 mesh	11.6	7.5	30 mesh	61.2	38.8
-30 +40 mesh	8.4	5.5	40 mesh	66.6	33.4
-40 +50 mesh	6.8	4.4	50 mesh	71.1	28.9
-50 +70 mesh	7.2	4.7	70 mesh	75.7	24.3
-70 +100 mesh	7.1	4.6	100 mesh	80.3	19.7
-100 +140 mesh	6.8	4.4	140 mesh	84.8	15.2
-140 +170 mesh	4.5	2.9	170 mesh	87.7	12.3
-170 +200 mesh	4.4	2.9	200 mesh	90.5	9.5
-200 +325 mesh	7.9	5.1	325 mesh	95.7	4.3
-325 mesh	6.7	4.3			
Total	154.1	100.0			

SIGNED: Les Dutt

DATE: 08/14/2001

Table 29: Sieve Analysis-Product-Phase 1

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 1) 14Aug, 1700 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	219.7 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	57.80 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.6	0.3	4 mesh	0.3	99.7
-4 +6 mesh	13.8	6.3	6 mesh	6.6	93.4
-6 +8 mesh	23.3	10.6	8 mesh	17.2	82.8
-8 +12 mesh	23.6	10.7	12 mesh	27.9	72.1
-12 +16 mesh	27.4	12.5	16 mesh	40.4	59.6
-16 +20 mesh	23.2	10.6	20 mesh	50.9	49.1
-20 +30 mesh	18.6	8.5	30 mesh	59.4	40.6
-30 +40 mesh	14.2	6.5	40 mesh	65.9	34.1
-40 +50 mesh	11.7	5.3	50 mesh	71.2	28.8
-50 +70 mesh	11.5	5.2	70 mesh	76.4	23.6
-70 +100 mesh	11.0	5.0	100 mesh	81.4	18.6
-100 +140 mesh	9.9	4.5	140 mesh	85.9	14.1
-140 +170 mesh	6.0	2.7	170 mesh	88.7	11.3
-170 +200 mesh	5.1	2.3	200 mesh	91.0	9.0
-200 +325 mesh	9.3	4.2	325 mesh	95.2	4.8
-325 mesh	10.5	4.8			
Total	219.7	100.0			

SIGNED: Les Dutt

DATE: 08/16/2001

Table 30: Sieve Analysis-Product-Phase 1

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 1) 14Aug, 1730 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	204.6 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	58.90 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.2	0.1	4 mesh	0.1	99.9
-4 +6 mesh	12.0	5.9	6 mesh	6.0	94.0
-6 +8 mesh	23.6	11.5	8 mesh	17.5	82.5
-8 +12 mesh	24.6	12.0	12 mesh	29.5	70.5
-12 +16 mesh	26.8	13.1	16 mesh	42.6	57.4
-16 +20 mesh	21.8	10.7	20 mesh	53.3	46.7
-20 +30 mesh	16.3	8.0	30 mesh	61.2	38.8
-30 +40 mesh	11.7	5.7	40 mesh	67.0	33.0
-40 +50 mesh	9.5	4.6	50 mesh	71.6	28.4
-50 +70 mesh	9.7	4.7	70 mesh	76.3	23.7
-70 +100 mesh	9.1	4.4	100 mesh	80.8	19.2
-100 +140 mesh	8.9	4.3	140 mesh	85.1	14.9
-140 +170 mesh	5.1	2.5	170 mesh	87.6	12.4
-170 +200 mesh	4.9	2.4	200 mesh	90.0	10.0
-200 +325 mesh	9.3	4.5	325 mesh	94.6	5.4
-325 mesh	11.1	5.4			
Total	204.6	100.0			

SIGNED: Les Dutt

DATE: 08/16/2001

Table 31: Sieve Analysis-Product-Phase 2

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 2) 14Aug, 1900 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	227.8 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	56.40 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.0	0.4	4 mesh	0.4	99.6
-4 +6 mesh	15.7	6.9	6 mesh	7.3	92.7
-6 +8 mesh	25.1	11.0	8 mesh	18.3	81.7
-8 +12 mesh	26.9	11.8	12 mesh	30.2	69.8
-12 +16 mesh	32.4	14.2	16 mesh	44.4	55.6
-16 +20 mesh	25.3	11.1	20 mesh	55.5	44.5
-20 +30 mesh	18.6	8.2	30 mesh	63.7	36.3
-30 +40 mesh	12.9	5.7	40 mesh	69.3	30.7
-40 +50 mesh	9.9	4.3	50 mesh	73.7	26.3
-50 +70 mesh	9.7	4.3	70 mesh	77.9	22.1
-70 +100 mesh	9.8	4.3	100 mesh	82.2	17.8
-100 +140 mesh	8.8	3.9	140 mesh	86.1	13.9
-140 +170 mesh	5.3	2.3	170 mesh	88.4	11.6
-170 +200 mesh	5.2	2.3	200 mesh	90.7	9.3
-200 +325 mesh	10.7	4.7	325 mesh	95.4	4.6
-325 mesh	10.5	4.6			
Total	227.8	100.0			

SIGNED: Les Dutt

DATE: 08/15/2001

Table 32: Sieve Analysis-Product-Phase 2

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Product (Phase 2) 14Aug, 1930 hr		Was Screen Sample Dried?		
			Yes:	No:	X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	208.6 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	58.40 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.9	0.4	4 mesh	0.4	99.6
-4 +6 mesh	12.9	6.2	6 mesh	6.6	93.4
-6 +8 mesh	24.9	11.9	8 mesh	18.6	81.4
-8 +12 mesh	27.3	13.1	12 mesh	31.6	68.4
-12 +16 mesh	31.0	14.9	16 mesh	46.5	53.5
-16 +20 mesh	23.1	11.1	20 mesh	57.6	42.4
-20 +30 mesh	16.5	7.9	30 mesh	65.5	34.5
-30 +40 mesh	11.0	5.3	40 mesh	70.8	29.2
-40 +50 mesh	8.8	4.2	50 mesh	75.0	25.0
-50 +70 mesh	8.2	3.9	70 mesh	78.9	21.1
-70 +100 mesh	8.6	4.1	100 mesh	83.0	17.0
-100 +140 mesh	8.2	3.9	140 mesh	87.0	13.0
-140 +170 mesh	5.6	2.7	170 mesh	89.6	10.4
-170 +200 mesh	4.5	2.2	200 mesh	91.8	8.2
-200 +325 mesh	9.6	4.6	325 mesh	96.4	3.6
-325 mesh	7.5	3.6			
Total	208.6	100.0			

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DATE: 08/15/2001

Table 33: Sieve Analysis-Product-Phase 3

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 3) 15Aug, 1030 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	297.1 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	57.50 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.6	0.5	4 mesh	0.5	99.5
-4 +6 mesh	30.3	10.2	6 mesh	10.7	89.3
-6 +8 mesh	39.0	13.1	8 mesh	23.9	76.1
-8 +12 mesh	38.5	13.0	12 mesh	36.8	63.2
-12 +16 mesh	45.1	15.2	16 mesh	52.0	48.0
-16 +20 mesh	31.3	10.5	20 mesh	62.5	37.5
-20 +30 mesh	21.9	7.4	30 mesh	69.9	30.1
-30 +40 mesh	15.5	5.2	40 mesh	75.1	24.9
-40 +50 mesh	11.5	3.9	50 mesh	79.0	21.0
-50 +70 mesh	11.0	3.7	70 mesh	82.7	17.3
-70 +100 mesh	10.6	3.6	100 mesh	86.3	13.7
-100 +140 mesh	9.6	3.2	140 mesh	89.5	10.5
-140 +170 mesh	6.0	2.0	170 mesh	91.5	8.5
-170 +200 mesh	5.6	1.9	200 mesh	93.4	6.6
-200 +325 mesh	9.0	3.0	325 mesh	96.4	3.6
-325 mesh	10.6	3.6			
Total	297.1	100.0			

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DATE: 08/15/2001

Table 34: Sieve Analysis-Product-Phase 4

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 4) 15Aug, 1200 hr (36.5° angle of repose)	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	171.4 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	56.50 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.9	0.5	4 mesh	0.5	99.5
-4 +6 mesh	15.3	8.9	6 mesh	9.5	90.5
-6 +8 mesh	20.6	12.0	8 mesh	21.5	78.5
-8 +12 mesh	18.8	11.0	12 mesh	32.4	67.6
-12 +16 mesh	22.7	13.2	16 mesh	45.7	54.3
-16 +20 mesh	18.5	10.8	20 mesh	56.5	43.5
-20 +30 mesh	13.3	7.8	30 mesh	64.2	35.8
-30 +40 mesh	9.3	5.4	40 mesh	69.7	30.3
-40 +50 mesh	7.6	4.4	50 mesh	74.1	25.9
-50 +70 mesh	7.4	4.3	70 mesh	78.4	21.6
-70 +100 mesh	7.4	4.3	100 mesh	82.7	17.3
-100 +140 mesh	6.3	3.7	140 mesh	86.4	13.6
-140 +170 mesh	3.8	2.2	170 mesh	88.6	11.4
-170 +200 mesh	4.0	2.3	200 mesh	91.0	9.0
-200 +325 mesh	6.9	4.0	325 mesh	95.0	5.0
-325 mesh	8.6	5.0			
Total	171.4	100.0			

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DATE: 08/15/2001

Table 35: Sieve Analysis-Product-Phase 5

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Product (Phase 5) 15Aug, 1330 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	230.7 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	57.10 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.2	0.5	4 mesh	0.5	99.5
-4 +6 mesh	21.8	9.4	6 mesh	10.0	90.0
-6 +8 mesh	28.8	12.5	8 mesh	22.5	77.5
-8 +12 mesh	30.0	13.0	12 mesh	35.5	64.5
-12 +16 mesh	32.8	14.2	16 mesh	49.7	50.3
-16 +20 mesh	24.9	10.8	20 mesh	60.5	39.5
-20 +30 mesh	17.4	7.5	30 mesh	68.0	32.0
-30 +40 mesh	12.0	5.2	40 mesh	73.2	26.8
-40 +50 mesh	9.3	4.0	50 mesh	77.2	22.8
-50 +70 mesh	9.2	4.0	70 mesh	81.2	18.8
-70 +100 mesh	8.7	3.8	100 mesh	85.0	15.0
-100 +140 mesh	8.0	3.5	140 mesh	88.5	11.5
-140 +170 mesh	5.0	2.2	170 mesh	90.6	9.4
-170 +200 mesh	4.1	1.8	200 mesh	92.4	7.6
-200 +325 mesh	7.9	3.4	325 mesh	95.8	4.2
-325 mesh	9.6	4.2			
Total	230.7	100.0			

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DATE: 08/15/2001

Table 36: Sieve Analysis-Product-Phase 6

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 6) 15Aug, 1630 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	238.9 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	59.30 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.0	0.4	4 mesh	0.4	99.6
-4 +6 mesh	21.3	8.9	6 mesh	9.3	90.7
-6 +8 mesh	31.9	13.4	8 mesh	22.7	77.3
-8 +12 mesh	30.8	12.9	12 mesh	35.6	64.4
-12 +16 mesh	32.4	13.6	16 mesh	49.1	50.9
-16 +20 mesh	24.6	10.3	20 mesh	59.4	40.6
-20 +30 mesh	17.5	7.3	30 mesh	66.8	33.2
-30 +40 mesh	12.7	5.3	40 mesh	72.1	27.9
-40 +50 mesh	9.8	4.1	50 mesh	76.2	23.8
-50 +70 mesh	10.2	4.3	70 mesh	80.5	19.5
-70 +100 mesh	9.8	4.1	100 mesh	84.6	15.4
-100 +140 mesh	8.5	3.6	140 mesh	88.1	11.9
-140 +170 mesh	5.1	2.1	170 mesh	90.2	9.8
-170 +200 mesh	5.4	2.3	200 mesh	92.5	7.5
-200 +325 mesh	8.9	3.7	325 mesh	96.2	3.8
-325 mesh	9.0	3.8			
Total	238.9	100.0			

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DATE: 08/16/2001

Table 37: Sieve Analysis-Product-Phase 7

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Product (Phase 7) 15Aug, 1830 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	185.3 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	55.20 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.8	0.4	4 mesh	0.4	99.6
-4 +6 mesh	17.3	9.3	6 mesh	9.8	90.2
-6 +8 mesh	23.9	12.9	8 mesh	22.7	77.3
-8 +12 mesh	24.0	13.0	12 mesh	35.6	64.4
-12 +16 mesh	25.4	13.7	16 mesh	49.3	50.7
-16 +20 mesh	19.3	10.4	20 mesh	59.7	40.3
-20 +30 mesh	13.5	7.3	30 mesh	67.0	33.0
-30 +40 mesh	9.5	5.1	40 mesh	72.2	27.8
-40 +50 mesh	7.6	4.1	50 mesh	76.3	23.7
-50 +70 mesh	8.2	4.4	70 mesh	80.7	19.3
-70 +100 mesh	7.9	4.3	100 mesh	84.9	15.1
-100 +140 mesh	7.3	3.9	140 mesh	88.9	11.1
-140 +170 mesh	4.6	2.5	170 mesh	91.4	8.6
-170 +200 mesh	3.0	1.6	200 mesh	93.0	7.0
-200 +325 mesh	6.4	3.5	325 mesh	96.4	3.6
-325 mesh	6.6	3.6			
Total	185.3	100.0			

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DATE: 08/16/2001

Table 38: Sieve Analysis-Product-Phase 8

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Product (Phase 8) 16Aug, 1100 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	169.3 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	58.00 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.5	0.3	4 mesh	0.3	99.7
-4 +6 mesh	16.8	9.9	6 mesh	10.2	89.8
-6 +8 mesh	23.0	13.6	8 mesh	23.8	76.2
-8 +12 mesh	22.6	13.3	12 mesh	37.2	62.8
-12 +16 mesh	22.6	13.3	16 mesh	50.5	49.5
-16 +20 mesh	16.4	9.7	20 mesh	60.2	39.8
-20 +30 mesh	11.8	7.0	30 mesh	67.2	32.8
-30 +40 mesh	8.7	5.1	40 mesh	72.3	27.7
-40 +50 mesh	7.2	4.3	50 mesh	76.6	23.4
-50 +70 mesh	7.2	4.3	70 mesh	80.8	19.2
-70 +100 mesh	6.7	4.0	100 mesh	84.8	15.2
-100 +140 mesh	6.2	3.7	140 mesh	88.4	11.6
-140 +170 mesh	3.9	2.3	170 mesh	90.7	9.3
-170 +200 mesh	2.8	1.7	200 mesh	92.4	7.6
-200 +325 mesh	6.8	4.0	325 mesh	96.4	3.6
-325 mesh	6.1	3.6			
Total	169.3	100.0			

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DATE: 08/20/2001

Table 39: Sieve Analysis-Product-Phase 9

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Product (Phase 9) 16Aug, 1300 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	193.3 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	60.80 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	1.9	1.0	4 mesh	1.0	99.0
-4 +6 mesh	24.9	12.9	6 mesh	13.9	86.1
-6 +8 mesh	28.1	14.5	8 mesh	28.4	71.6
-8 +12 mesh	24.3	12.6	12 mesh	41.0	59.0
-12 +16 mesh	28.8	14.9	16 mesh	55.9	44.1
-16 +20 mesh	20.3	10.5	20 mesh	66.4	33.6
-20 +30 mesh	14.2	7.3	30 mesh	73.7	26.3
-30 +40 mesh	9.4	4.9	40 mesh	78.6	21.4
-40 +50 mesh	7.1	3.7	50 mesh	82.3	17.7
-50 +70 mesh	6.6	3.4	70 mesh	85.7	14.3
-70 +100 mesh	5.8	3.0	100 mesh	88.7	11.3
-100 +140 mesh	5.2	2.7	140 mesh	91.4	8.6
-140 +170 mesh	3.2	1.7	170 mesh	93.0	7.0
-170 +200 mesh	2.6	1.3	200 mesh	94.4	5.6
-200 +325 mesh	5.9	3.1	325 mesh	97.4	2.6
-325 mesh	5.0	2.6			
Total	193.3	100.0			

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DATE: 08/20/2001

Table 40: Sieve Analysis-Product-Phase 10

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Product (Phase 10) 16Aug, 1430 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	162.4 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	55.50 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.2	0.1	4 mesh	0.1	99.9
-4 +6 mesh	16.2	10.0	6 mesh	10.1	89.9
-6 +8 mesh	24.7	15.2	8 mesh	25.3	74.7
-8 +12 mesh	24.0	14.8	12 mesh	40.1	59.9
-12 +16 mesh	25.4	15.6	16 mesh	55.7	44.3
-16 +20 mesh	17.8	11.0	20 mesh	66.7	33.3
-20 +30 mesh	12.5	7.7	30 mesh	74.4	25.6
-30 +40 mesh	9.0	5.5	40 mesh	79.9	20.1
-40 +50 mesh	7.3	4.5	50 mesh	84.4	15.6
-50 +70 mesh	7.1	4.4	70 mesh	88.8	11.2
-70 +100 mesh	5.6	3.4	100 mesh	92.2	7.8
-100 +140 mesh	4.0	2.5	140 mesh	94.7	5.3
-140 +170 mesh	1.6	1.0	170 mesh	95.7	4.3
-170 +200 mesh	1.4	0.9	200 mesh	96.6	3.4
-200 +325 mesh	2.7	1.7	325 mesh	98.2	1.8
-325 mesh	2.9	1.8			
Total	162.4	100.0			

SIGNED: Les Dutt

DATE: 08/20/2001

Table 41: Sieve Analysis-Filter Fines-Phase 1

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Filter Fines (Phase 1) 14Aug, 1730 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	71.6 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	40.70 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.1	0.1	70 mesh	0.1	99.9
-70 +100 mesh	0.1	0.1	100 mesh	0.3	99.7
-100 +140 mesh	0.6	0.8	140 mesh	1.1	98.9
-140 +170 mesh	1.0	1.4	170 mesh	2.5	97.5
-170 +200 mesh	1.7	2.4	200 mesh	4.9	95.1
-200 +325 mesh	11.9	16.6	325 mesh	21.5	78.5
-325 mesh	56.2	78.5			
Total	71.6	100.0			

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DATE: 08/16/2001

Table 42: Sieve Analysis-Filter Fines-Phase 2

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 2) 14Aug, 1930 hr		Was Screen Sample Dried?		
			Yes:	No:	X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	78.3 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	39.40 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.1	0.1	70 mesh	0.1	99.9
-70 +100 mesh	0.1	0.1	100 mesh	0.3	99.7
-100 +140 mesh	0.8	1.0	140 mesh	1.3	98.7
-140 +170 mesh	1.6	2.0	170 mesh	3.3	96.7
-170 +200 mesh	2.8	3.6	200 mesh	6.9	93.1
-200 +325 mesh	10.5	13.4	325 mesh	20.3	79.7
-325 mesh	62.4	79.7			
Total	78.3	100.0			

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DATE: 08/15/2001

Table 43: Sieve Analysis-Filter Fines-Phase 3

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 3) 15Aug, 1030 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	59.6 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	39.00 #/cf (dry)	
U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.0	0.0	70 mesh	0.0	100.0
-70 +100 mesh	0.1	0.2	100 mesh	0.2	99.8
-100 +140 mesh	0.5	0.8	140 mesh	1.0	99.0
-140 +170 mesh	1.0	1.7	170 mesh	2.7	97.3
-170 +200 mesh	1.7	2.9	200 mesh	5.5	94.5
-200 +325 mesh	7.4	12.4	325 mesh	18.0	82.0
-325 mesh	48.9	82.0			
Total	59.6	100.0			

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DATE: 08/15/2001

Table 44: Sieve Analysis-Filter Fines-Phase 4

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Filter Fines (Phase 4) 15Aug, 1200 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	68.9 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	39.40 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.1	0.1	70 mesh	0.1	99.9
-70 +100 mesh	0.1	0.1	100 mesh	0.3	99.7
-100 +140 mesh	0.7	1.0	140 mesh	1.3	98.7
-140 +170 mesh	1.3	1.9	170 mesh	3.2	96.8
-170 +200 mesh	1.6	2.3	200 mesh	5.5	94.5
-200 +325 mesh	9.0	13.1	325 mesh	18.6	81.4
-325 mesh	56.1	81.4			
Total	68.9	100.0			

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DATE: 08/15/2001

Table 45: Sieve Analysis-Filter Fines-Phase 5

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 5) 15Aug, 1330 hr		Was Screen Sample Dried?		
			Yes:	No:	X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	60.3 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min		Bulk Density:	39.30 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.0	0.0	70 mesh	0.0	100.0
-70 +100 mesh	0.1	0.2	100 mesh	0.2	99.8
-100 +140 mesh	0.5	0.8	140 mesh	1.0	99.0
-140 +170 mesh	1.0	1.7	170 mesh	2.7	97.3
-170 +200 mesh	2.2	3.6	200 mesh	6.3	93.7
-200 +325 mesh	8.6	14.3	325 mesh	20.6	79.4
-325 mesh	47.9	79.4			
Total	60.3	100.0			

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DATE: 08/15/2001

Table 46: Sieve Analysis-Filter Fines-Phase 6

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 6) 15Aug, 1630 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	78.7 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	40.40 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.1	0.1	70 mesh	0.1	99.9
-70 +100 mesh	0.1	0.1	100 mesh	0.3	99.7
-100 +140 mesh	0.6	0.8	140 mesh	1.0	99.0
-140 +170 mesh	1.3	1.7	170 mesh	2.7	97.3
-170 +200 mesh	1.6	2.0	200 mesh	4.7	95.3
-200 +325 mesh	10.4	13.2	325 mesh	17.9	82.1
-325 mesh	64.6	82.1			
Total	78.7	100.0			

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DATE: 08/16/2001

Table 47: Sieve Analysis-Filter Fines-Phase 7

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Filter Fines (Phase 7) 15Aug, 1830 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	74.6 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min	Bulk Density:	38.40 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.1	0.1	70 mesh	0.1	99.9
-70 +100 mesh	0.1	0.1	100 mesh	0.3	99.7
-100 +140 mesh	0.6	0.8	140 mesh	1.1	98.9
-140 +170 mesh	1.3	1.7	170 mesh	2.8	97.2
-170 +200 mesh	1.8	2.4	200 mesh	5.2	94.8
-200 +325 mesh	11.2	15.0	325 mesh	20.2	79.8
-325 mesh	59.5	79.8			
Total	74.6	100.0			

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DATE: 08/15/2001

Table 48: Sieve Analysis-Filter Fines-Phase 8

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 8) 16Aug, 1100 hr		Was Screen Sample Dried?		
			Yes:	No:	X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	73.1 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	39.30 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.0	0.0	70 mesh	0.0	100.0
-70 +100 mesh	0.1	0.1	100 mesh	0.1	99.9
-100 +140 mesh	0.5	0.7	140 mesh	0.8	99.2
-140 +170 mesh	1.5	2.1	170 mesh	2.9	97.1
-170 +200 mesh	1.2	1.6	200 mesh	4.5	95.5
-200 +325 mesh	11.6	15.9	325 mesh	20.4	79.6
-325 mesh	58.2	79.6			
Total	73.1	100.0			

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DATE: 08/16/2001

Table 49: Sieve Analysis-Filter Fines-Phase 9

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY		Date Rec'd:	07/17/2001	
			Sample No.	010747	
Material:	Filter Fines (Phase 9) 16Aug, 1300 hr		Was Screen Sample Dried?		
			Yes:		No: X
Project No.:	1-56563-865-00-30		Wt. of Sample Tested:	76.9 g	
Moisture as Rec'd.:			Bulk Density:	#/cf (wet)	
Method of Screening:	Hand screen to 8m. Rotap -8m for 10 min		Bulk Density:	37.80 #/cf (dry)	

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.0	0.0	70 mesh	0.0	100.0
-70 +100 mesh	0.1	0.1	100 mesh	0.1	99.9
-100 +140 mesh	0.4	0.5	140 mesh	0.7	99.3
-140 +170 mesh	1.2	1.6	170 mesh	2.2	97.8
-170 +200 mesh	2.1	2.7	200 mesh	4.9	95.1
-200 +325 mesh	10.3	13.4	325 mesh	18.3	81.7
-325 mesh	62.8	81.7			
Total	76.9	100.0			

SIGNED: Les Dutt

DATE: 08/16/2001

Table 50: Sieve Analysis-Filter Fines-Phase 10

FC-1024-3

F.L.SMIDTH INC. - RESEARCH DEPARTMENT

LABORATORY SCREEN ANALYSIS

Sample From:	Solvay Minerals Green River, WY	Date Rec'd:	07/17/2001
		Sample No.	010747
Material:	Filter Fines (Phase 10) 16Aug, 1430 hr	Was Screen Sample Dried?	
		Yes:	No: X
Project No.:	1-56563-865-00-30	Wt. of Sample Tested:	61.6 g
Moisture as Rec'd.:		Bulk Density:	#/cf (wet)
Method of Screening:	Hand screen to 8m, Rotap -8m for 10 min	Bulk Density:	37.70 #/cf (dry)

U.S. Screen	Grams Retained	% Retained		Cumul.% Retained	Cumul.% Passing
+2 inch	0.0	0.0	2 inch	0.0	100.0
-2 +1 ¾ inch	0.0	0.0	1 ¾ inch	0.0	100.0
-1 ¾ +1 ½ inch	0.0	0.0	1 ½ inch	0.0	100.0
-1 ½ +1 ¼ inch	0.0	0.0	1 ¼ inch	0.0	100.0
-1 ¼ +1 inch	0.0	0.0	1 inch	0.0	100.0
-1 +¾ inch	0.0	0.0	¾ inch	0.0	100.0
-¾ +½ inch	0.0	0.0	½ inch	0.0	100.0
-½ +3/8 inch	0.0	0.0	3/8 inch	0.0	100.0
-3/8 +¼ inch	0.0	0.0	¼ inch	0.0	100.0
-¼ +4 mesh	0.0	0.0	4 mesh	0.0	100.0
-4 +6 mesh	0.0	0.0	6 mesh	0.0	100.0
-6 +8 mesh	0.0	0.0	8 mesh	0.0	100.0
-8 +12 mesh	0.0	0.0	12 mesh	0.0	100.0
-12 +16 mesh	0.0	0.0	16 mesh	0.0	100.0
-16 +20 mesh	0.0	0.0	20 mesh	0.0	100.0
-20 +30 mesh	0.0	0.0	30 mesh	0.0	100.0
-30 +40 mesh	0.0	0.0	40 mesh	0.0	100.0
-40 +50 mesh	0.0	0.0	50 mesh	0.0	100.0
-50 +70 mesh	0.0	0.0	70 mesh	0.0	100.0
-70 +100 mesh	0.1	0.2	100 mesh	0.2	99.8
-100 +140 mesh	0.7	1.1	140 mesh	1.3	98.7
-140 +170 mesh	1.4	2.3	170 mesh	3.6	96.4
-170 +200 mesh	1.9	3.1	200 mesh	6.7	93.3
-200 +325 mesh	9.8	15.9	325 mesh	22.6	77.4
-325 mesh	47.7	77.4			
Total	61.6	100.0			

SIGNED: Les Dutt

DATE: 08/20/2001

LABORATORY TEST REPORT
Page 1

FFE MINERALS USA INC.

3235 Schoenersville Road♦ P.O. Box 810♦ Bethlehem, Pennsylvania 18016-0810
Telephone: 610-264-6900 ♦ FAX: 610-264-6996

TO: Ron Riddle FROM: W. E. Lindquist DATE: 17 May 2001
2001-56549-865-00-30

COMPANY: SOLVAY
GREEN RIVER, WY

SUBJECT: TEST RESULTS

Solvay wants to convert their existing calciners from natural gas to coal firing; however, they first want to determine what effect the coal ash retained in the calcined trona may have on product quality.

To get an understanding of the coal ash effect, a series of tests were undertaken and are listed below:

1. **Coal Analysis** (See Table 1)
   a. Proximate
   b. Ash Complete
   c. Ash Fusion
   d. Hardgrove

2. **Coal Ash** (See Table 2)
   a. Soluable Silica (Ash above ash fusion temp.)
   b. Soluable Silica (Ash below Ash fusion temp.)

3. **Thermal Analysis (DTA/TGA)** (See Figure 1)

4. **Muffle Furnace Burns**
   a. Trona with no coal ash addition.
   b. Trona with coal ash addition. Ash produced below ash fusion temperature. Ash addition based on 1.4 MBTU/ton of trona feed, or 0.44 gms ash/100 gms trona.
   c. Trona with coal ash addition. Ash produced above ash fusion temperature. Ash addition based on 1.4 MBTU/ton of trona feed, or 0.44 gms ash/100 gms trona.

The burned furnace product was analyzed for total SiO_2. The burned product was also treated with 10% NaOH (see Appendix A for procedure). The residue remaining after dissolution with the NaOH was analyzed for total SiO_2. The results from the muffle furnace burns are shown in Table 3.

The results indicate that approximately 96% of the burned product was soluble in the NaOH. The primary interest was the solubility of the SiO_2, which was calculated from the results shown in Table 3. For the trona with no coal ash addition, 7.35% of the total SiO_2 in the sample was soluble. For the trona with coal ash addition, 21.5% of the total SiO_2 in the sample was soluble for the coal ash produced below the ash fusion temperature vs 14.2% for the coal ash produced above the ash fusion temperature.

Fuel Analysis

20-Apr-01

Customer Name: Solvay
Location: Green River, WY
Lab No: 010329
Sample Description: Coal
Analytical No: C010343

Bulk Density as Received:

Moisture as Received: 18.77

Proximate Analysis (Dry Basis)

Vol:	39.68
Ash:	7.61
FC:	52.71
Sulfur (%S)	0.60
BTU/Lb:	12,097
Cl:	
Hardgrove Index:	48.6

Ultimate Analysis (Dry Basis)

Ult. C:	71.53
Ult. H:	5.01
Ult. N:	1.68
Ult. S:	
Ult. O:	13.57

Chemistry of Ash

SiO2:	47.08
Al2O3:	28.98
Fe2O3:	3.31
CaO:	8.75
MgO:	2.53
K2O:	0.34
Na2O:	0.53
SO3:	0.03
P2O5:	2.87
TiO2:	0.81
Mn2O3:	2.50
Total:	97.73

IT- Initial Deformation Temperature: 2100°F
ST- Softening Temperature: 2300°F
HT- Hemispherical Temperature: 2375°F
FT- Fluid Temperature: 2450°F

Table 2

COAL ASH SOLUBLE SiO_2

A. **Coal Ash (Below Ash Fusion Temperature)**

1. Before Treatment with NaOH — 47.08% SiO_2
2. Insoluble Residue After Treatment with *NaOH (81.1% Insol) — 42.47% SiO_2

18.9% of total sample is soluble and
26.8% of total SiO_2 is soluble

B. **Coal Ash (Above Ash Fusion Temperature)**

1. Before Treatment with NaOH — 47.8% SiO_2
2. Insoluble Residue After Treatment with NaOH (85.8% Insol) — 45.78% SiO_2

14.2% of total sample is soluble and
17% of total SiO_2 is soluble

*** See Appendix A**

Table 3

RESULTS FROM MUFFLE FURNACE BURNS AT 175°C

a. **Trona (No Ash Addition)**

	% SiO_2	% LOI	% SiO_2 Loss Free
1. Burned Product	0.922	45.36	1.687
2. Burned Product Residue After Treatment*			
4.07% Insoluble	27.806	27.59	38.40

95.93% of the total sample is soluble and 7.35% of the total SiO_2 is soluble.

b. **Trona + Ash (Below Ash Fusion Temperature)**

	% SiO_2	% LOI	% SiO_2 Loss Free
1. Burned Product	1.185	44.15	2.123
2. Burned Product Residue After Treatment*			
4.1% Insoluble	30.512	24.92	40.639

95.93% of the total sample is soluble and 21.5% of the total SiO_2 is soluble.

c. **Trona + Ash (Above Ash Fusion Temperature)**

	% SiO_2	% LOI	% SiO_2 Loss Free
1. Burned Product	1.228	36.97	1.948
2. Burned Product Residue After Treatment*			
4.18% Insoluble	29.065	27.31	39.985

95.82% of the total sample is soluble and 14.2% of the total SiO_2 is soluble.

*** After Treatment with 10% NaOH (See Appendix A)**

Table 4

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH/NELAC 10903 • NJ DEP 77020
• AIHA ACCREDITATION NO 100439 • PA DEP 06-353 • CT DPH PH-0238
• NC DENR 599

ANALYTICAL REPORT

Client: F.L. Smidth Inc. R&D Dept.

Report to: Steve Schmidt, Chem. Lab
F.L. Smidth Inc. R&D Dept.
Front & Willow Streets
P.O. Box 189
Catasauqua PA 18032

Project: 203206
Received: 03-MAY-01
Reported: 10-MAY-01

PURCHASE ORDER: 251-1-8239-08

Project Description: Trace Heavy Metals

	RESULT	UNITS	METHOD	DATE	ANALYST
C010481, Lab #010330 (a-1)					
Lab Sample: 1447697 Trona Burned Product					
Moisture			2540G		
Antimony, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Arsenic, Total	0.730	mg/kg	6010	07-MAY-01	JLP
Barium, Total	14.5	mg/kg	6010	07-MAY-01	JLP
Beryllium, Total	0.126	mg/kg	6010	07-MAY-01	JLP
Cadmium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Chromium, Total	4.93	mg/kg	6010	07-MAY-01	JLP
Lead, Total	0.929	mg/kg	6010	07-MAY-01	JLP
Nickel, Total	0.724	mg/kg	6010	08-MAY-01	AJB
Selenium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Silver, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Thallium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Vanadium, Total	1.82	mg/kg	6010	07-MAY-01	JLP
Mercury, Total	< 0.04	mg/kg	7471	09-MAY-01	JDC
C010482, Lab #010330-M1 (b-1)					
Lab Sample: 1447698 Trona + Ash (Reg.) Burned Product					
Moisture			2540G		
Antimony, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Arsenic, Total	0.800	mg/kg	6010	07-MAY-01	JLP
Barium, Total	29.7	mg/kg	6010	07-MAY-01	JLP
Beryllium, Total	0.139	mg/kg	6010	07-MAY-01	JLP
Cadmium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Chromium, Total	4.82	mg/kg	6010	07-MAY-01	JLP
Lead, Total	1.06	mg/kg	6010	07-MAY-01	JLP
Nickel, Total	0.836	mg/kg	6010	08-MAY-01	AJB
Selenium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Silver, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH/NELAC 10903 • NJ DEP 77020
• AIHA ACCREDITATION NO 100439 • PA DEP 06-353 • CT DPH PH-0238
• NC DENR 599

Client: F.L. Smidth Inc. R&D Dept.
Project: 203206

	RESULT	UNITS	METHOD	DATE	ANALYST
C010482, Lab #010330-M1					
Lab Sample: 1447698 - continued					
Thallium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Vanadium, Total	2.18	mg/kg	6010	07-MAY-01	JLP
Mercury, Total	< 0.04	mg/kg	7471	09-MAY-01	JDC
C010483, Lab #010330-M2 (c-1)					
Lab Sample: 1447699 Trona + Ash (Fused) Burned Product					
Moisture			2540G		
Antimony, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Arsenic, Total	0.767	mg/kg	6010	07-MAY-01	JLP
Barium, Total	29.3	mg/kg	6010	07-MAY-01	JLP
Beryllium, Total	0.144	mg/kg	6010	07-MAY-01	JLP
Cadmium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Chromium, Total	4.95	mg/kg	6010	07-MAY-01	JLP
Lead, Total	1.06	mg/kg	6010	07-MAY-01	JLP
Nickel, Total	0.915	mg/kg	6010	08-MAY-01	AJB
Selenium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Silver, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Thallium, Total	< 0.500	mg/kg	6010	07-MAY-01	JLP
Vanadium, Total	2.07	mg/kg	6010	07-MAY-01	JLP
Mercury, Total	< 0.04	mg/kg	7471	09-MAY-01	JDC

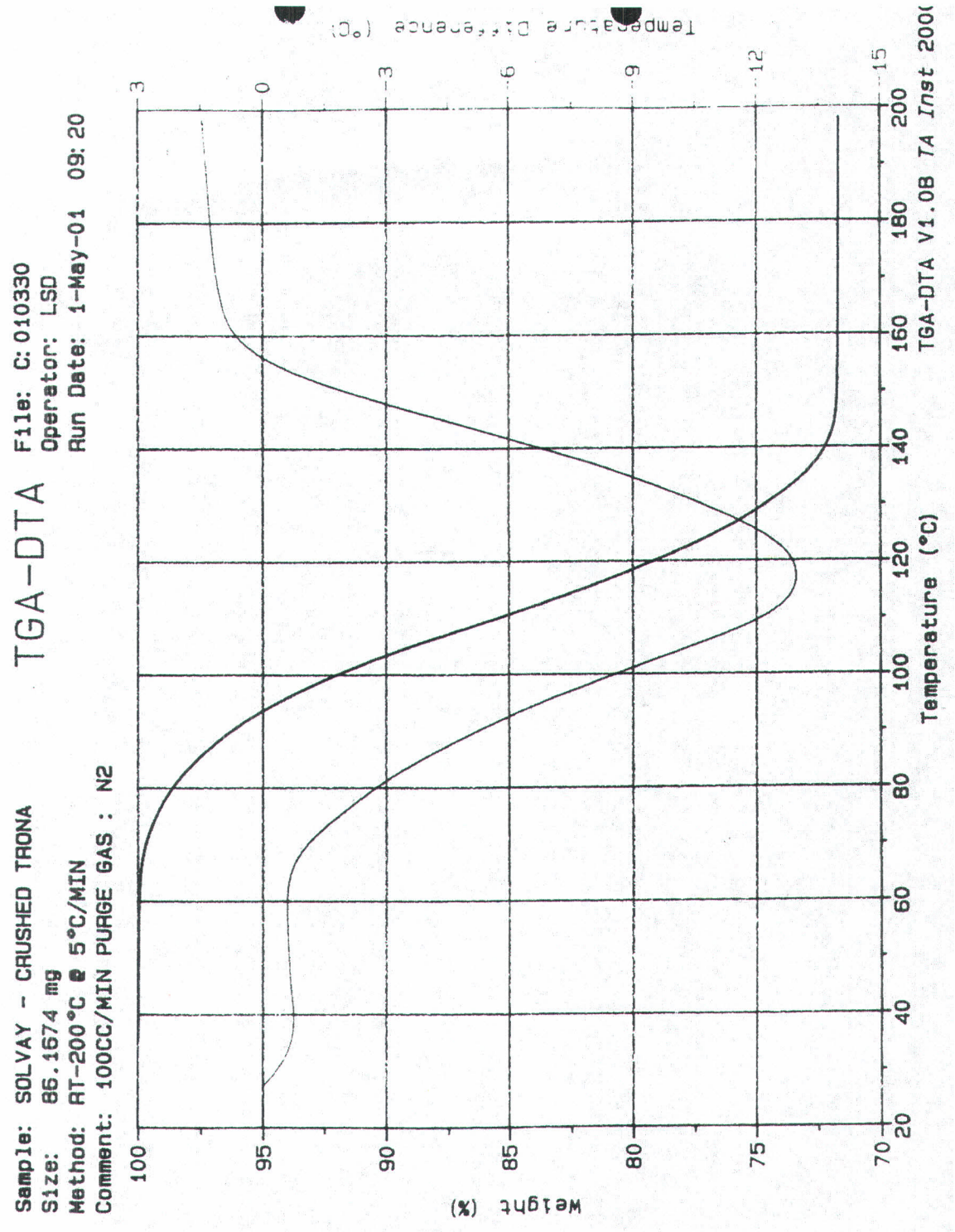
< Indicates less than the limit of quantitation.

APPENDIX A

PROCEDURE FOR SOLUBLE SiO_2

Weigh an appropriate amount of material into a 400 ml beaker (use 5.000 grams for coal ashes and 10.0000 grams for trona samples). Add 100 ml of 10% NaOH to the material in the beaker. Bring to a boil on a hot plate. Boil for 10 minutes. Filter hot through a "previously-weighed" Whatman No. 40 filter paper. Wash the residue on the filter paper 3 times with hot D.I. water. Place (the filter paper with the residue) on a "previously-weighed" watch glass and dry in a 105°C oven for approximately 1.5 hours. Reweigh the filter paper + residue + watch glass and determine the percent of residue. Record the % Residue.

Prepare a glass fused pellet of the residue with the aid of our Claisse Bis Fluxer. Determine total SiO_2 via wavelength-dispersive X.R.F. analytical technique.


TGA-DTA
Sample: SOLVAY - CRUSHED TRONA
Size: 86.1674 mg
Method: RT-200°C @ 5°C/MIN
Comment: 100CC/MIN PURGE GAS : N2
File: C:010330
Operator: LSD
Run Date: 1-May-01 09:20
weight (%)
Temperature (°C)
TGA-DTA V1.0B TA Inst 200
100
95
90
85
80
75
70
20
40
60
80
100
120
140
160
180
200
3
0
-3
-6
-9
-12
-15

LABORATORY TEST PROCEDURE-BICARB ANALYSIS

Table 51: Bicarb Procedure-Page 1

Solvay Minerals, Inc. Green River, Wyoming
Technical Services Department
Originator - Dave Smith Approver - Jim Phillip

SODIUM BICARBONATE PROCEDURE PROCESS LIQUORS

TEC-05-046 06 Mar. 2000 Rev. 02

SCOPE

This is a spot test method that covers the determination of sodium bicarbonate in process liquors and rake underflows.

SUMMARY

Sodium hydroxide (NaOH) is reacted with the sodium bicarbonate ($NaHCO_3$)in the process liquors until all the bicarbonate is converted to carbonate. At this time the excess NaOH will react with silver nitrate to form Ag_2O, a brown precipitate.

SAFETY

Both the NaOH and silver nitrate will burn and are extremely hazardous if swallowed. If skin contact is made, flush with plenty of water.

EQUIPMENT

150 ml and 250 ml beakers
Stir plate
Ceramic spot plate
25 ml buret
Plastic disposable pipets

REAGENTS

DI water - deionized water from lab water treatment system (minimum rating 10 umhos/cm conductivity at 25^0 C).
0.1 N Sodium Hydroxide (NaOH) - Weigh 4 g of NaOH to two decimal places accuracy and transfer into a 1000 ml volumetric flask and dilute to volume with DI water.
1:12 silver nitrate - 1 part $AgNO_3$ + 12 parts DI water

PROCEDURE

1. Weigh approximately 25 g to two decimal place accuracy of rake underflow sample into a

Table 52: Bicarb Procedure-Page 2

250 ml beaker.

2. Add 100 ml of DI water to the 250 ml beaker, place on stir plate and stir until only shale and grits remain, then filter.

3. Weigh approximately 10 g of underflow filtrate or of the liquor sample into 150 ml beakers to two decimal place accuracy.

4. Add approximately 50 ml of DI water to each 150 ml beaker and place on stir plate.

5. Transfer the $AgNO_3$ to the spot plate reservoirs.

6. Using a plastic disposable pipet, add 2 drops of the test solution to the spot plate reservoir containing the silver nitrate solution.

7. Check to see if the sample turns the silver nitrate brown (not off-white). If a brown color precipitates, calculate the % $NaHCO_3$, if not continue with step # 8.

8. Add 1 ml of 0.1N NaOH from a buret to the stirring sample.

9. Repeat steps 6-8 until addition of the sample turns the silver nitrate brown.

10. Record the mls of NaOH titrated.

CALCULATIONS

Calculate the normality of NaOH:

$$N = \frac{g / 40}{V}$$

Where:

N	=	normality of NaOH
g	=	weight in grams of NaOH
40	=	equivalent weight of NaOH
V	=	volume diluted to in liters

$$\% NaHCO_3 = \frac{N * ml * 0.084 * 100}{g}$$

Where:

0.084	=	milliequivalent weight of sodium bicarbonate
N	=	normality of sodium hydroxide (NaOH)

For Process Liquors

Table 53: Bicarb Procedure-Page 3

g = weight in grams of liquor
ml = ml of sodium hydroxide (NaOH) titrated

For Rake Underflows

$$g = \frac{\text{Weight(g) of rake underflow sample} * \text{weight(g) of underflow solution}}{\text{Weight(g) of rake underflow sample} + 100\text{g of DI water}}$$

ATTACHMENT

TEC-05-046A 06/03/2000 % Sodium Bicarbonate Chart

REVISION HISTORY

Rev. 01 Added rake underflows to scope of procedure and updated procedure steps and calculations to reflect rake underflows

Rev. 02 Format changed to HTML format for Intranet

Changes for most recent revision appear in *red italics.*